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The Street Railway Convention.

The convention now being held by the American Street & Interurban Railway Association at Atlantic City, promises to be like so many of its predecessors, one of the most important meetings of the year in which it is held. The street railway industry has grown tremendously since electricity was applied to it, and the magnitude of the interests involved in a development that now represents up to $4,000,000,000 of capitalization needs no emphasis. Fortunately the association has as a body responded to the call upon it, and under able and influential leadership exerts throughout its field a power wholly for good. The largeness of the attendance and the excellence of the exhibits alike testify to the drawing capacity of the annual convention, and we are glad to note the high quality, also, of the papers brought before the parent and allied associations. Prof. Swenson, the secretary, and the special committees, are indeed to be warmly commended for their preparatory work along these lines. Moreover, the scheme of alliance or cooperation between the various bodies embraced under the generic name appears to be working out admirably. In short, the doubts that hung over the future of this great association a few years ago have been thoroughly dissipated, and the new career of usefulness lies ahead, a track of well-laid, shining rails.

The Technical Graduate and the Electric Railway.

Elsewhere we print an abstract of a paper presented this week by Prof. H. H. Norris before the Atlantic City Convention of the American Street & Interurban Railway Association, which invites the most earnest attention of those in charge of electric railway properties. The manufacturing branch of the electrical industry has for many years recognized the value to it of the technical graduate, and at present openings in every department of that industry leading to positions of responsibility and profit, are reserved for him alone, and a similar situation in the central-station field is being rapidly developed. On the other hand, as Prof. Norris points out, those in charge of electric railway properties have in recruiting their staffs offered little or no encouragement to this element. Indeed, their attitude of indifference has been such as to recall the earlier days of the electrical industry, when the technical graduate was regarded with pity when he was not ridiculed as an absurdity. The reason for this anomaly appears to be that in the past conduct of the electric railway, questions of finance and of policy towards the public have been considered of the first importance, and have been given a preponderating weight in the selection of higher railway officials; and there has been lacking a form of organization whereby proper consideration of such questions may be possible without minimizing attention to others of high importance incident to the managerial and technical conduct of electric railway properties, with respect not only to present conditions, but also with regard to preparations for the conditions of the future. In other words, there appears

to have been a lack of that permanency of organization policy which enables a telephone company to estimate conditions over a future period of a score of years, and to prepare in advance plans to meet these conditions as they arise; and similarly, which enables electric lighting companies to estimate increase in business and to prepare and file away plans for future increase of equipment to correspond.

It is certainly high time that the loose organization of electric railways, so far as pertains to staff, should be changed to correspond with the practice of other branches of the electrical industry and with that of our more successful steam railroads. This implies resort to a definite system for recruiting the raw material of the personnel and for molding it into shape, coupled with assurance of permanent tenure and a chance of promotion for faithful service. As to raw material, the technical schools may be drawn upon for an ideal supply, not alone for the engineering department but for utilization, after a probationary period, in every department of the electric railway. Experience with technical graduates extending now over 15 years, has completely demonstrated that, owing to the flexibility of mind and systematic habit of thought and work which results from their scholastic training, and an esprit de corps which dignifies any task allotted and incites zeal to its performance, they can, if taken as fledglings into an organization which knows how to adapt their capabilities to its needs, and after a period of general training, be drafted for permanent service equally as efficient in the executive and commercial branches of the organization as in the technical branch. Prof. Norris, in his paper, outlines an admirable scheme for the preliminary training of the young graduate for electric railway service, during the period of which he is worked over from raw material to a state fitting him for duty in any branch. This scheme cannot be too strongly commended to those who may decide to recognize the technical schools as a source upon which to draw in building up and maintaining an efficient and permanent electric railway organization of personnel; for failure in many cases may be predicted should such a decision merely result in taking on the young men with no provision for a probationary period of systematic training having for its purpose the development along specific lines of their potential value at the plastic period of life.

Some Questions in Ethics.

One who frequently reads specifications for engineering works is continually and sadly impressed with the lack of such definite canons of righteousness as should properly define what may and what may not be done in the way of implicitly demanding the output of particular makers. It is frequent enough to find more or less clumsily concealed in general phrases limitations which practically eliminate all chance for open competition. Doubtless such limitations may sometimes be inserted almost unconsciously, the author of them having, perhaps somewhat vaguely, particular things in mind and erring merely in describing them somewhat too closely. In other cases he evidently means to favor certain articles while preserving the possibility of competition, and again he may draw so close a description that the terms could be met only by infringing the patents of the favored maker. Anyone who is used to reading specifications can easily classify them in somewhat this fashion, and gains thereby no great respect for the integrity of their authors. Now in point of fact, the author is probably more upright than his specifications, and part of the difficulty arises from lack of a definite moral law in such matters, and also from inexactitude in describing the really general properties of the article desired.

As regards the latter count in the indictment, very few engineering students get adequate training in expressing themselves for the purposes of their professional work. Such training in English as they get is generally viewed from the academic side only. It would be well if special training in writing specifications were regularly given, as it sometimes is to a rather meagre extent, but bearing directly upon the meaning of descriptions and their legal force. The other matter is more difficult. Some engineers undoubtedly think they are doing their full duty by describing the concrete things which they prefer and letting the makers fight it out among themselves afterwards. Others go to the opposite extreme of describing things very vaguely and letting the bidders guess at the real requirements. For instance, it is perfectly easy to draw such a specification for a traveling crane as shall give only a single maker a chance to bid on a standard product, or to specify it so loosely that one will be overwhelmed with useless and discordant bids. Of course, the use of patented articles raises the specification question in its acutest form. It strikes us that in this particular matter the ethical considerations are perfectly plain. If for good reason an engineer believes that the best interests of his client demand the use of a particular patented thing, he should fully inform his client of the situation and then call for the thing he wants in plain words, without any attempt at open competition. As a rule, by so doing he is likely to get fully as good terms as by inciting a bogus competition. Moreover, an engineer who thus conducts his affairs does not lay himself open to the suspicion of unfair dealing.

In case there are no patents to be infringed but makers have very different standards, even to the point of differing widely in method, it is next to impossible to draw a specification that shall be both accurately descriptive and entirely fair. In such a case the engineer either has or has not made up his mind as to what form of apparatus is conspicuously best for the purpose in hand. If he has, his duty is plain, just as in the case of patented articles. If relative advantages are pretty closely balanced, and several makes can meet the requirements acceptably, though with quite different appliances, patented or not, then there is a clear case for a very open specification, to be sent, not broadcast, but only to those who are on approximately even terms. It is little short of indecent to ask for bids from people who on the face of things stand no show of putting in an acceptable offer. Finally it may be that there are no obvious leaders in the race, in which case a fully detailed specification covering the thing wanted should be prepared with scrupulous care that no peculiarities of particular makers find place in it. Such a specification can be sent out pretty freely without doing injustice to anybody. No finely drawn code of ethics is needed to enforce fairness in drawing up and sending out specifications, but only a keen sense of honor and a determination to give everybody a square deal. Since, however, electrical engineers are to be blessed with an official code of ethics, the subject here considered might appropriately receive recognition in it, even though exigencies of limited space would thereby require the elesion from the draft of the proposed code,

of the delphic admonition concerning "standards of construction," which ethical precept on occasions would probably be construed against newly developed types of apparatus if they came in competition with so-called standard types established by manufacturers.

Regulations for Safety in the Operation of Central Stations.

Every year brings along with increased use of electricity and electric apparatus a corresponding need for increasing care in the handling and control of this apparatus. This is particularly the case with installations that extend the territory of high-tension transmission, or that increase their voltage over a given territory. While it is true that year by year there is more training and knowledge of the dangers of careless installation, yet on the other hand, there are ever more untrained and unskilled persons being drawn into the service of electric supply, either at the generating stations or on consumers' premises, with the result that precautions have to be more widely advocated in order to protect those whose training has not fitted them to protect themselves. The *Elektrotechnische Zeitschrift* has recently published an additional series of safety regulations for central-station service adopted by the Verband Deutscher Elektrotechniker. These are set out with the detail and precision which characterize public precautionary measures in Germany. The most important of these refer to storage-battery installations and to high-tension installation; that is, to installations employing pressures exceeding 750 volts in the case of direct-current power. Some of the rules would seem to be of an obviously necessary character. For example, it is set down that eating, drinking and smoking are to be forbidden in storage-battery rooms. All epicures familiar with storage-battery work would certainly endorse this rule. It is, of course, well to err on the safe side when deciding what to ordain and what not to ordain, in dealing with safety regulations for personnel. Clear notices of danger to person from electric discharge are called for in every case of risk and it is stated that such notices must be on placards not less than 8 x 4 ins.

The Institution of Electrical Engineers of Great Britain has also recently issued a series of Wiring Rules for securing satisfactory results with electrical supply and distribution at e. m. f.'s not exceeding 250 volts. These rules state in general what constructions may not be used. It is questionable whether such rules should be promulagted by an engineering body. They should unquestionably be promulgated by a proper authority, but that authority should be one which possessed power to enforce the rules. An engineering body naturally seeks to find the best, safest and most economical methods of construction and seeks to advocate such methods. It does not, however, form a court of enquiry into all installations, to see whether good methods have been followed, and with a view to mulcting or admonishing offenders who may have carelessly or irregularly installed. This is the natural task and duty of insurance interests. It is the insurance officers who should be qualified to say what construction should not be used and it is the engineering institutions that should be occupied by determining what construction should be used. So long as the two bodies cooperate in committee, their respective duties can best be performed when they are governed by separate rules and are kept apart.

Excitation Characteristics of the Synchronous Motor.

Although the complete theory of the relations between the internal m. m. f.'s, fluxes, reactances and e. m. f.'s of the synchronous motor may be worthy of careful study from the standpoint of the designing engineer, yet it is a matter of indifference from the standpoint of the operating engineer. The operating engineer wants to understand the action of the synchronous motor to the extent at least of being able to protect, control and fully utilize the machine. But he must have comparatively simple rules and formulæ to guide him. Long and difficult formulas do not usually help to elucidate ideas, and particularly do not help the man who has to apply his knowledge in sudden practical emergencies. The operating engineer's theory of the synchronous motor must be, quantitatively, a fairly simple one. The only hope we have of keeping a reasonably simple set of formulæ and working theory of synchronous motor action is to make certain assumptions which are not strictly justified, and compare the results so arrived at with observations on actual machines. If the quantitative results reached by simplified formulas are not far from the observed facts, the simplified theory becomes acceptable, at least to a first degree of approximation. If, on the other hand, the simplified assumptions do not lead to substantially verified conclusions, then the theory attempted must be rejected as untenable. The simplest assumptions are, perhaps, that a synchronous motor has no armature reaction, but has a virtual synchronous reactance, which includes the effect of armature reaction, which remains constant at all loads. It may be also assumed that the currents and e. m. f.'s are simple sinusoids, and that the degree of saturation of the magnetic circuits is relatively low as well as constant. On this simple basis a working theory of synchronous motors has been developed by various students of these machines. It is, however, admitted to be applicable to a first approximation only, although the actual error or deviation between the results of the theory and the results of actual observation are but imperfectly understood. It is probable, however, that such formulas, which are not too difficult for the use of the operating engineer, apply with a sufficient degree of accuracy for most practical purposes.

In the article appearing on page 762 of this number, Prof. A. S. Langdorf develops the theory of synchronous-motor excitation characteristics one stage further than the above—namely, by taking into account an armature-reaction m. m. f., separate and apart from the reactance of the armature. This is one stage nearer to the facts of the case. The formulas derived are not much harder to handle than those of the simpler synchronous reactance theory. What would be of great interest in this connection is a series of careful observations on the behavior of one or more synchronous motors under definitely varied excitation and load, to ascertain how much nearer to the mark the new theory may come than the old theory. There seems to be room for a careful set of comparative reasearches on a basis of motors, undertaken with the object of determining how nearly our various existing synchronous-motor theories apply. It is important, however, that those who conduct and sum up these researches should not allow themselves to be influenced by preconceived notions in favor of any particular theory.

Convention of the American Street & Interurban Railway Association.

The annual convention of the American Street & Interurban Railway Association and its affiliated bodies, consisting of the Accountants', Engineering and Claim Agents' Associations, was held in Atlantic City, N. J., Oct. 14 to 18, 1907. The meetings of the parent body were held on the Steel Pier on Oct. 16, 17 and 18, while the sessions of the Engineering Association were also held on the Steel Pier on Oct. 14, 15 and 16. The meetings of the Claim Agents' Association were held in the St. Charles Hotel, Oct. 14, 15 and 16, and the Accountants' Association met in the Chalfonte Hotel on Oct. 15, 16 and 17.

MONDAY'S SESSION.

The opening session of the Engineering Association began at 2:40, Monday afternoon, with the president, Mr. H. H. Adams, in the chair. Immediately after the session opened, Mr. John I. Beggs, president of the parent association, made an address in which he dwelt at length on the importance of the work undertaken by the Engineering Association. He pointed out that the engineers are the right hands of the executive heads of the railway companies upon whom rests the success of the administration of the properties. The standardization of the various methods of operation means, he said, the saving of dollars and cents. His motto was not the best possible service, but the best service practicable under the conditions of operation. Mr. Beggs commented on the harmony existing between the affiliated association and the parent organization, which condition, he said, was conducive to effective work.

Following Mr. Beggs' address, Mr. C. L. S. Tingley, president of the Accountants' Association, delivered a few words of greeting. He was followed by Mr. E. W. Olds, past president of the affiliated association. President Adams then read his address. In it, he called attention to the advantages of committee work, and said that the work of the standardization committee demonstrated the necessity of going further into such work, so that the various parts of railway equipment might be treated separately. He recommended that committees be appointed to cover the subjects of wheels, axles, brake-shoes and heads, motors and various other important items so that the best results be obtained. Commenting on the work of the standardization committee he said that its work represented not only the views of the operating men, but those of the manufacturer as well. The committee met with a cordial response from motor designers in its work toward uniform practice in gearing for motors, and in motor design. The recommendations of the committee, he said, cover the best practice, and the importance of their adoption, from a commercial standpoint alone, is very great. In the name of the association he thanked the committee for its work.

The reports of the executive committee, treasurer and secretary were then read and adopted. The committee on control apparatus in lieu of a report had Mr. F. E. Case, of the General Electric Company, give what data his company had upon the latest developments in control apparatus for railway equipments. A number of changes made in controllers were noted, with the reasons therefor. The paper went into the subjects of changes to meet the requirements of higher voltages.

Speaking on the subject, Mr. J. W. Corning made some remarks with reference to the adjustment of the steps on the accelerating rheostat. One of the officials of the Boston Elevated Railway Company reported cases of uneven acceleration on a number of cars. Recording ammeters were applied and in some instances it was found that the setting of the resistance connections was very bad. For instance, it was found that on the last step in parallel, just before going into full multiple, there was a peak of about 325 amperes in accelerating on a grade of about 5 per cent. The average current in multiple on the controller in question was much larger than the average current in series per motor. By a readjustment of the resistances the peak was brought down to about 190 amperes. Much trouble was also experienced with flashing of motors, blowing of fuses and short circuits in the controller; but since the readjustment of the resistances these troubles disappeared.

Mr. W. Roberts stated that in his opinion the secret of successful operation lies in the thoroughness of the inspection of the equipment, both night and day.

Mr. N. W. Storer, speaking for the Westinghouse Electric & Manufacturing Company, said that his company still has the electro-pneumatic type of multiple-unit control, and is using the same contactors for both alternating and direct current. For direct-current work his company employs a battery for the valve magnets, and the same battery and valve magnet apply for alternating current, the only difference between the contactors being in the blow-out, which is modified slightly for alternating currents. The heavy pressure on the contactors, combined with an effective blow-out, makes a good operating switch. The Westinghouse Company, Mr. Storer said, believes in a multiple unit equipment not only for heavy work, but for street car service as well.

Mr. L. I. Smith then presented the report of the committee on maintenance and inspection of electrical equipment. The paper gives the result of a canvass of electric railway companies, to whom questions on the subject of the committee's work were sent. The committee discusses in detail many of the replies received, which together cover a wide range of subjects, and in some cases definite conclusions are based upon the information received.

TUESDAY'S SESSIONS.

The whole of the meeting on Tuesday morning was devoted to the report of the committee on way matters. F. G. Simmons, the chairman of the committee, stated that the report includes the results of investigations which are embodied in reports of the various sub-committees. One report was presented in the form of a paper by L. Wilson on the care of electric railway tracks. This paper dealt with interurban tracks, city tracks, oil sprinkling and snow removal. The discussion was opened by E. O. Ackerman, who remarked that the maintenance bill after the track has been laid depends very largely upon the original construction. He expressed the opinion that the most effective work is done at the lowest cost when use is made of the best laborers available. C. H. Clark stated that best results are obtained when the maximum use is made of machinery in preparing and maintaining the roadway. Mr. Simmons said he believes in amplifying the use of machinery by preparing written specifications for all persons connected with the work. A. M. Schreiber remarked that one great disadvantage in using track machinery is that it interferes with the traffic. Boardman Reed explained in detail the working of the plan used in New York City for paying for the removal of snow. For the last few years the snow has been removed by contract, the price paid being determined by the depth of snow as recorded by the weather bureau. The subject of the proper tiling for drainage was discussed by E. N. T. Ryder, E. O. Ackerman, M. J. French, and W. J. W. Griffin.

The report of the sub-committee on rail corrugations was presented by the chairman, F. G. Simmons. This report embodied the replies to a circular letter sent to the various members. Out of 48 replies only 13 contained any definite information on the subject, and even these were considerably at variance with each other. The chairman remarked that the investigation of rail corrugation should be referred in the future to a committee dealing with all of the details of the rails. In opening the discussion, G. L. Wilson called attention to the curious fact that although the corrugations are ascribed to defects in the foundation, yet almost all of the cases of corrugated rails occur in paved streets. The irregularities may be removed by filing the rails, but their recurrence is not prevented. C. Voynow expressed the opinion that the corrugations are caused by the elongation of the upper surface of the metal under traffic. It has been noted that the firmer the foundation of the rail the more readily do the corrugations occur. It has been found that after the rail has been thoroughly filed the corrugation does not occur again. It is probable that

the filing causes the metal to be knitted into a more firm consistency. W. B. Reed stated that his observations confirm the theory of Mr. Voynow. In reply to a question by E. W. Olds, Mr. Voynow said that when the corrugations first form they are perpendicular to the rail. As they increase in size they become cone-shaped. They change in form regularly and constantly approach a nipple in shape, but no creeping has been observed. Mr. Voynow suggested that a systematic investigation of the corrugations should be carried out by the committee on rails.

The report of the sub-committee on rails and rail matters was presented by Chas. E. Clark. As a result of its study the sub-committee recommended as a standard for city construction in paved streets, a 7-in. T-rail, known as the Lorain section No. 95,400 and the Pennsylvania Steel Company's section No. 272. Mr. Simmons, as chairman of the committee on maintenance of ways, said that there are probably from 50 to 100 types of rails in use in the various cities, and it is desirable, if possible, to reduce the number of types to two or three. It is not the intention, however, to recommend the T-rail as the best for all service conditions. The report, which was not discussed, was the last item on the Tuesday morning's program.

At the session Tuesday afternoon the most important committee of the Engineering Association, the committee on standardization, presented its report. So great was the interest in this report that the convention hall was crowded. The report deals with axles, journals and journal fittings, brake shoes and their fittings, wheel treads and flanges and rails. The text of the report consists principally of references to a large number of accompanying drawings.

In the discussion which followed the reading of the report N. W. Storer, speaking for the Westinghouse interests, asked that that portion of the report relating to the overhang of the gear hub on the gear for small axles be changed so as to permit the placing of the gear flush on the motor side and making the overhang on the wheel side 1⅛ ins. The matter was left in abeyance until after the convention. E. W. Olds said that it was a matter of very great importance for the association to adopt standards, since by this means it would be possible for the operating companies to change one motor for another on the same truck.

M. Ayers, speaking for the Boston Elevated Railroads, suggested that some changes be made in the axle dimensions and that keyways be omitted, especially for high-speed work. Objection, however, was made to any change since the committee felt that its report covered the best practice of the day, and that it would be difficult to reconcile a report of this character to the practice of every individual road. C. S. Sergeant and E. G. Connette, of the American Association, spoke of the need of some standardization and sympathized with the committee in its difficulty in arriving at recommendations with respect to a department where nothing before was standard. Mr. Evans spoke of the difficulty in getting motor designers, truck builders, wheel manufacturers and axle makers to agree. The recommendations made by the committee, he said, very nearly coincide with the standards adopted by the largest railway systems of the country.

A. H. Weston, speaking for journal-box manufacturers, said that he believed that the association in adopting the journal-box standard as recommended by the committee would confer a great benefit on the traction companies. One of the most discouraging things to the journal-box manufacturer up to the present time has been the great variety of patterns he had to carry to supply traction companies' demands.

The recommendations regarding brake shoes and brake-shoe heads met with the approval of the manufacturers, who were anxious to reduce the number of patterns necessary to carry in stock.

The section of the report dealing with standard sections of tread and flange of wheel brought out a long discussion in which is was shown that despite the objections made in some quarters, a wide tread is desirable for interurban work and even in city work, the wide tread in the latter case resulting in increasing the wheel mileage from 15,000 to 20,000.

The report was finally adopted as read, and presented to the American Street & Interurban Railway Association for its approval. The committee was given a vote of thanks for its work, and in reply said that it hoped its recommendations would be put into practical use.

The report of the committee on open versus closed terminals for car houses was then read. The committee on operating and storage car house designs not being able to prepare anything for definite presentation to the association, the final order of business, the Question Box, was then taken up for discussion. The only questions brought up for further discussion concerned lightning arresters and where to place them. The answers showed that many companies placed the lightning arresters on high spots and in deep railway cuts; others distributed them at least every half-mile on interurban lines; while still others clustered them thickly around the power house. One company marked on a map the points where lightening struck oftenest. By this means it was enabled to know where to put the lightning arresters to the best advantage, with the result that the burn-outs due to this cause were reduced enormously.

WEDNESDAY'S SESSIONS.

The opening session of the American Association and joint meeting of the affiliated associations took place in Casino Hall over the entrance to the Steel Pier on Wednesday morning.

After the usual addresses and committee reports, Prof. H. H. Norris of Cornell University read his paper on "The Technically Trained Man and the Electric Railway Profession," an abstract of which appears elsewhere in this issue. This paper was followed by one written by Ralph Sweetland on "The National Fire Protection Association." "The Influence of the Design of Railway Structures on Economy of Operation," by H. T. Campion and William McClellan was the title of the final paper of the morning session.

At the Wednesday afternoon session, the following papers were read before the Engineering Associations: "A Year's Experience with Gas Engines," by Paul Windsor, an abstract of which will appear next week; "Some Practical Points in Steam Turbine Construction, with Particular Reference to the Parsons Type," by St. John Chilton; "Operation of Curtis Turbines in Railway Service," by A. H. Kruesi, and "Recent Developments in Steam Turbine Power Station Work," by J. R. Bibbins. Abstracts of these three papers follow.

The paper by Mr. Chilton described certain improvements that have been introduced in the Parsons type of turbine as built by the Allis-Chalmers Company. He stated that in reaction turbines small clearances between stationary and rotating blades, in line with the flow of steam, are unnecessary. In practice the clearance is never less than ⅛ in. between the smallest blades, and it is often as much as ¾ in. between the largest blades. Thus ample room is allowed for difference in expansion of the rotor and the cylinder. It is essential, however, to minimize the leaking of steam past the ends of the blades, where it does no work. The necessity for small radial clearance has demonstrated the advisability of protecting the tips of the blades to prevent them from being knocked out through accidental contact with the cylinder or the rotor. A method that experience has proved both practical and effective is one in which the blades are cut from drawn stock, and each blade is formed by special machine tools so that at its root it is of angular dovetail shape, while at its tip there is a projection. To hold the roots of the blades firmly there is provided a foundation ring which is first formed to a circle of the proper diameter, and then slots are cut in it by a special milling machine, and these, accurately spaced and inclined to give the required pitch and angle to the blades, are of dovetail shape to receive the roots of the blades. The tips of the blades are substantially bound together and protected by means of a channel-shaped shroud-ring, in which are holes punched to receive the projections on the tips of the blades. The blading is made

up in half-rings, built by machine and not by hand. With this construction any blading trouble would be localized and damaged rings can be removed and the turbine can continue in operation until such rings can be replaced conveniently. Mr. Chilton stated that the improvements effected by this construction may be summed up as follows: 1, firm attachment of blades; 2, ample stiffening of blades of all lengths against effects of vibration; 3, accurate spacing and accurate angles of blades; 4, protection of blade-tips, so that accidental contact will not rip out blades; 5, smaller clearance, resulting in diminished steam-leakage and, hence, increased economy; 6, improved baffling against steam-leakage by reason of the shape of the shroud-ring; 7, protection against a possibly defective blade coming out and destroying other blades; 8, accurate machine work, as against uncertain hand work; 9, the facility for thorough inspection of workmanship; 10, the localizing of any possible trouble and the convenience of making quick repairs.

A paper by August H. Kruesi outlined the results obtained with Curtis steam turbines in actual railway service. A 9000-kw turbo-generator used by the Commonwealth Electric Company, Chicago, Ill., consumes 13 lbs. of steam per kw-hour. A 5000-kw unit installed in the power station of the Edison Illuminating Company, of Boston, consumes 14 lbs. of steam per kw-hour. A 2000-kw unit in the Westville power house of the West Jersey & Seashore Railroad Company consumes 16.2 lbs. of steam per kw-hour at full load. The tests on the above machines showed that the total steam used per hour varies regularly with the load from a certain value at no load. In the Boston Edison unit the value at no load was 12.5 per cent of the total amount at full load. The additional quantity of steam per kw over and above the fixed amount at no load was 12.1 lbs. per hour. In a theoretically perfect engine driving a generator at unity efficiency the increase in consumption would be 9.27 lbs. per kw-hour. Thus the added amount of steam was used in the turbine at an efficiency of 76.4 per cent.

Probably the greatest single improvement which has been effected in the Curtis turbines relates to the governors. All of the turbines for large 25-cycle generators are now equipped with hydraulically operated valves controlled by balanced pilot valves connected to the governor and taking oil from the step-bearing pumping system. These governors have proved reliable, permanent in adjustment, sensitive and responsive to abrupt changes in load and they require very little attention in operation. They are ordinarily set for a 2 per cent change in speed from no-load to full-load, which degree of regulation is sufficiently large to afford stable operation of generators in parallel.

The step bearings of the machines are now lubricated with oil instead of water which was formerly employed. The change to oil involves the use of an additional shaft packing where the turbine shaft passes through the base, but as this packing has only to seal against the atmosphere its duty is relatively light and its operation simple. The upper bearings of these machines are now being lubricated under pressure from the step oiling system, thus dispensing with tanks and sight-feed glasses. The pressure lubrication enables the bearings to be supplied with any quantity of oil desired. It is found that a flooded condition of lubrication in the guide bearings gives the best operation of the machines as regards freedom from vibration. The oil is filtered continuously.

A paper outlining recent developments in steam-turbine generating stations, with special reference to the Spy Run station of the Fort Wayne & Wabash Valley Traction Company, was presented by Mr. J. R. Bibbins. It was shown that a Westinghouse-Parsons turbo-generator of large size requires only 1/20 sq. ft. of floor area per generator horse-power, which is less than ¼ of that required by a horizontal Corliss, and less than ⅓ of that occupied by a vertical Corliss. In a few very large stations (above 10,000 kw) the investment cost has been somewhat less than $100 per kw. In the Spy Run 8500-kw station the total cost was $66.25 per kw of total generating rating. This cost was distributed as follows: Building $10.97; generating plant, complete, $30.55; boiler plant, $13.92; condenser plant, $3.98; coal-handling plant, $0.94; erection superintendence, engineering and miscellaneous, $5.94. It is interesting to note that a positive pressure fan has been installed to insure ventilation of the generators. This system of ventilation has the advantage of maintaining low generator temperature throughout the whole year. Moreover, a large excess of air can be supplied to any of the units that may for any reason be overloaded abnormally. Thus the fan blast in a generator auxiliary allows greater overload to be carried without damage.

An Electric Light Celebration.

A memorable banquet was given at Delmonico's, New York City, on Oct. 12, by Charles R. Huntley, of Buffalo, past president of the National Electric Light Association, to his former associates in the electrical industry. It was his fiftieth birthday, and the generous and felicitous idea had occurred to him on his recent return from Europe to celebrate it in this manner. There were 44 guests present out of the 47 invited, and the regrets of the absentees were poignant. An epitome in itself of 25 years of electrical history, the gathering was also delightful as a reunion of old friends, many of whom had not seen each other in years; and the rapidity of change and of events was shown by the fact that C. W. Price was the only man present who attended the preliminary gathering to organize the body in Chicago in 1885. Mr. Huntley gave a place next to himself, it should be noted, to the veteran master of transportation, C. O. Baker, who, by coincidence, celebrated his own fiftieth birthday on the twelfth.

The dinner was given in the famous red room, scene of many notable festivities, and the guests assembled at a huge round table banked profusely in ferns and flowers, in the center of which sparkled all the evening a multi-colored electric fountain. The sorbet was served in little mugs with appropriate inscriptions and the ice cream was served in dainty satin boxes containing a little primary battery, each capped with an incandescent lamp in full glow.

By request of the host, T. C. Martin officiated as toastmaster. Most admirable speeches were made in the following order by Samuel Insull, W. J. Clark, Edward Weston, Nikola Tesla, John J. Carty, Wm. Stanley, H. G. Stott, C. L. Edgar, G. F. Porter, John A. Seely and Alex. Patterson—men and names in themselves suggesting the living story of the arts with which they have been associated. It may be noted that there were four past presidents of the National Electric Light Association present, viz., Huntley, Insull, Edgar and Arthur Williams. Mr. Stott, who spoke as president of the American Institute of Electrical Engineers, began his professional career in this country in Mr. Huntley's employ, laying the underground system of Buffalo and inaugurating "Niagara power" there. Every speaker was full of reminiscences and data of a most interesting character, and every health was a literal "salamander."

In addition to those already named, were the following well-known "old timers": W. M. Habirshaw, H. L. Shippy, Morris M. Mead, Alex. Henderson, George Jackson, J. R. Lovejoy, George Urban, W. C. Warren, De Lancy Rankine, Ambrose Butler, Henry Stanley, James Kempster, Ed. Peck, E. E. Bartlett, A. J. de Camp, H. H. Harrison, E. S. Keefer, F. A. C. Perrine, R. B. Corey, P. C. Ackerman, C. D. Shain. Mr. Huntley was accompanied by his two sons, both in the industry, and Mr. Urban by his son, also engaged in work at Buffalo.

During the evening a flash-light photograph was taken of the assemblage, and a copy was presented later by the thoughtful host to every one of his guests. The dinner closed with a final rousing health to "Charlie" Huntley, and the singing of "Auld Lang Syne," but even then the party did not break up and the jubilee was still in full swing when Sunday morning dawned serenely.

October A. I. E. E. Meeting.

The October meeting of the American Institute of Electrical Engineers was held on Friday, the 11th, in the auditorium of the Engineering Societies' Building, President H. G. Stott being in the chair. The meeting was devoted to the discussion of the grounded neutral, with and without series resistance, in high-tension systems, a paper on this subject being presented by Mr. P. M. Lincoln. Experience papers on the same subject were read by Mr. F. G. Clark and Mr. George I. Rhodes. Abstracts of the above papers are given elsewhere in this issue.

President Stott stated that of the 5100 members of the Institute, 4600 reside in this country, and 22 per cent of the latter live within one hour's travel of New York City. To meet the needs of the members who cannot conveniently attend the New York section, 17 University branches and 20 local sections have been organized. It is the intention to broaden the scope of the Institute work so as to include not only electrical engineering but also the "allied arts and sciences" as mentioned in the constitution. The old high-tension transmission committee has been made a sub-committee of the papers committee, and a new sub-committee on railways has been formed. Moreover, a committee on education has been authorized, and a special meeting will be devoted to educational subjects. President Stott suggested the appointment of a reception committee in each large city for assisting visiting foreign engineers. The annual banquet will probably be held in January, at which time several distinguished guests will deliver addresses.

Buying and Selling Illumination.

A paper with the above title was presented before the recent meeting of the Empire State Gas and Electric Association by Mr. Elliott, of which an abstract follows.

After a preliminary general consideration of the subject, the question of what measurements should be used as a basis for the payment of street illumination, was discussed. With reference to the intensity of illumination, four different measurements were detailed as determining factors in the general result: 1. Maximum illumination; 2. minimum illumination; 3. average illumination; 4. illumination at a given distance from the lamp.

Which one or more of these measurements should be used? Maximum illumination was dismissed with little argument. Beyond a certain intensity, which is reached with all ordinary light-sources at the present time, a high maximum illumination is a defect, rather than an advantage, and if any use is made of it, therefore, it should be rather to limit it to a certain intensity.

Maximum illumination has many points of advantage. If a certain minimum illumination were specified, motives of economy would induce efforts to reduce the maximum to the lowest possible degree, with a result that a more nearly uniform intensity of illumination would be obtained; and this is the one most desirable improvement to be sought for over the methods that now prevail in street lighting. There are a considerable number of cases, however, in which the minimum is so low as to render its measurement too inexact for practical purposes.

This brings out the fact that street lighting may be divided in two quite distinct classes: First, street illumination, in which every part of the street is sufficiently illuminated to make it plainly visible; and, second, what may be termed beacon lighting, in which no attempt is made at general illumination of the entire street, but merely to use a sufficient number of light-sources to indicate the direction and location of the street. The name is suggested by the similarity of this kind of lighting to the use of lighthouses in harbors and waterways. Beacon lighting forms by no means an inconsiderable part of street lighting. In fact, it is not improbable that the total number of miles of streets lighted in this manner is larger than the mileage of illuminated streets. This cannot generally be set down as a fault. There are a great many cases in which this kind of street lighting serves the purpose sufficiently well, and in which the use of a large enough quantity of light to illuminate the entire length of the street would be unjustifiable expense. If minimum illumination is to be taken as a standard, upon which to base street lighting contracts, it is evident that it can only be applied to those streets which may be classed as "illuminated," leaving beacon-lighted streets to be provided for on some other basis.

Average illumination is evidently subject to the same limitations as minimum illumination, *i. e.*, it would be practcally unsuitable for beacon-lighted streets.

Illumination at a given distance from the base of the light-source offers a way out of the difficulties presented by minimum illumination, and is the method recommended by the committee of the National Electric Light Association, which had the matter under advisement last year. This method amounts practically to the use of the intensity of the light given out by the source at a certain angle. This is theoretically objectionable, as putting a premium on freak illumination, *i. e.*, illumiation which has its brilliancy concentrated in one given spot. Practically, however, this objection is of little force, since there are no available means of abnormally concentrating the light at an angle beyond 45 deg. The actual working of such a standard would, therefore, be to secure a minimum illumination at a stated distance from the lamps, and a higher degree of illumination between that point and the base of the lamp. The height of the lamp must, of course, in such a case be specified.

In the case of street illumination, as distinguished from beacon lighting, there seems to be no practical objections to the use of minimum illumination as a basis. This method, carried out in its fullest sense, leaves the whole question of light-sources, height, distance apart and accessories used wholly within the choice of the seller.

The result of making this the basis of a contract would invariably be the use of light-sources of small candle-power, except possibly in the rare cases in which a very high minimum was specified for the purpose of producing spectacular effects. In this case arc lamps would probably hold their own, but in most other cases would be hopelessly outclassed by incandescent electric or gas lamps.

The electric lighting interests have frankly admitted their opposition to such a method of measuring street illumination, for the reason that it would give the advantage to the light; but this is only one side of the story. If better street illumination can be produced at less cost with gas than electricity, the public, *i. e.*, the buyer, will naturally demand gas lighting. What the public wants is the best illumination for the money expended, and is quite unconcerned whether this is produced by gas or electricity with arcs, incandescents, or what not. It may be stated as a safe prophesy that what the people want they will in the end have. Ignorance or artificial conditions may for a time restrain the march of progress, but the fittest will always survive and come to the front.

In the case of beacon lighted streets, the only possible method of basing it upon the measurement of illumination, is by the illumination produced at a given distance from the base of the lamp placed at a given height. As previously stated, this amounts practically to specifying a lamp having a certain distribution of its rays, and it would be simpler and more satisfactory to make such a specification at once.

The payment for street illumination on the basis of the illumination produced offers advantages to both buyer and seller. The buyer pays for the actual goods delivered, it puts a premium upon progress and improvement, of which the producer will reap the first advantage. Thus, if a more efficient form of lamp is developed by which the stated illumination can be produced at less cost, it is obvious that the producer will be the gainer, at least for a greater or less length of time.

A reform, therefore, which works to the advantage of all parties, and to the disadvantage of none, is worthy of at least a most careful and serious consideration. That there is ample need of reform in the general practice of street lighting, both

professional and laymen must agree, and there is no surer means of inaugurating such a reform than to make better practices profitable to all concerned.

Direct-Current Motor-Control Systems.

A patent issued to Mr. W. J. Richards on Sept. 24, containing 54 claims, relates to a modification of the control system for mill and hoisting motors described on page 610 of our issue for Sept. 28. As noted in Fig. 1 the field windings of the motor

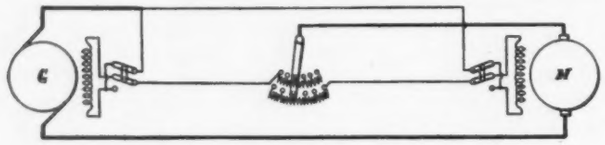


FIG. 1.—CONTROL SYSTEM FOR REVERSIBLE MILL MOTORS.

and the generator are in parallel with each other and in series with the armatures of these machines. The relative values of the currents in the field windings of the two machines are adjustable inversely by the movement of a single rheostat arm.

A second patent issued on the same date to the same inventor deals with a system for controlling a single motor from a number of different positions. The controller, which is diagram-

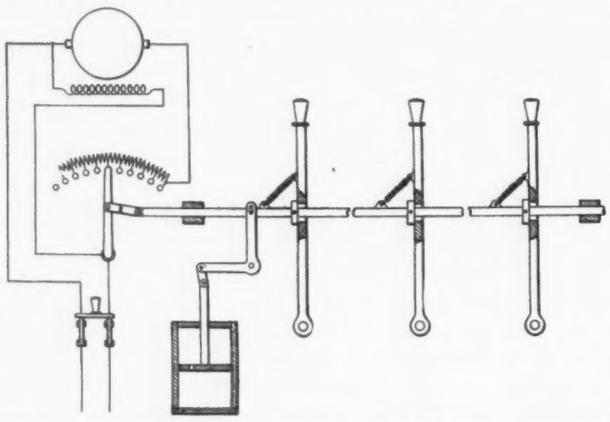


FIG. 2.—CONTROLLING A MOTOR FROM SEVERAL DIFFERENT POSITIONS.

matically illustrated in Fig. 2, is so arranged that if different operators conflict in simultaneously attempting to move the controller, the one desiring to decrease the speed of the motor or to operate at the smallest speed will prevail. In case two or more of the operating handles are simultaneously moved dissimilarly, the controller arm will move to the point determined by that handle which is moved farthest to the left, the movement of the other handle or handles merely putting under tension the spring or springs associated therewith.

Electrical Development in Asia Minor.

U. S. Consul-General G. B. Ravndal furnishes some interesting details as to trolley development at Beirut, Asiatic Turkey, and Consul W. C. Myelssen also states that a trolley system is to be built from Bagdad to a suburb, El Azamieh, distant about three miles. In both instances, it is urged that American manufacturers should pay closer attention to this field. Mr. Ravndal says: Some of the streets of Beirut are being widened and buildings torn down to give room for this modern improvement. In the old town a passage is being cut through an almost solid mass of square, flat-roofed stone houses erected more than a century ago. Of all the cities of the Ottoman Empire, Damascus was the first to employ electricity. Beirut is now following in the wake.

The concession for Beirut, which holds good for 99 years, was granted by the Sultan's Government to an Ottoman corporation, which in turn leased its charter to a Belgian company. The director-general informs me that the company is spending some $500,000 for rails, rolling stock, machinery, cables, buildings, tools, etc., and that a large portion of the material needed has been ordered in Belgium, some minor bills being filled in Germany and France. For the generation of electricity the company has decided to use coal.

Electric light will speedily be introduced in Beirut by the owners of the present gas plant. American trade in new markets would be greatly encouraged and promoted by American investments of capital for the development of natural resources which lie dormant and in public works. Our capital seems too timid and too suspicious of foreign conditions.

Underground vs. Overhead Distribution.

In a paper presented before the recent meeting of the Empire State Gas & Electric Association, Mr. W. W. Cole considered the subject of the agitation for the substitution of underground for overhead distribution from central stations.

There is undoubtedly, he said, an increasing desire to substitute underground lines for overhead, and generally where this is done the company has been granted a more liberal franchise, especially in cities of the third class, on account of the small income per hundred feet of conduit, and the city has granted an increased price per lamp and the company has had to maintain higher prices on the sale of current. The conclusion I have come to after considerable correspondence and investigation is that the cost of installation of an underground system, including conduit, manholes and cable, is about four times the cost of overhead construction. Overhead services can be run to consumers free, while an underground service will cost from $1.20 to $1.50 per foot, in proportion to the capacity and conditions. In one city in the state the charge for underground service is at the rate of $1 per foot from the curb to the inside wall of the customer's premises, and 10 cents per foot for overhead service under the same method of measurement. The interruptions from the alternating-current distribution system have been numerous and annoying, both to the company and consumer. It is estimated where street lighting is furnished from underground that it costs $20.50 per year over and above that of overhead service. In a recent contract in a city of northern New York they received $10 per lamp per year more. The additional price of $10 instead of $20 was made on account of their having more than half of the lamps to be supplied from the underground system. Another city, in a recent contract, was allowed $19 more for each new lamp supplied from the underground. By referring to the schedule of lighting prices throughout the country you will observe that all companies are charging very much higher prices when lamps are being furnished from underground circuits. But I desire to specialize somewhat on cities of the third class, and in several I believe conditions are against the placing of wires underground. First, additional cost of street lighting; second, additional cost to consumers for underground services; third, service from underground wire is less reliable than from overhead. This applies particularly to alternating-current distribution. One of the chief arguments raised against overhead wire lines is that they interfere with the work of firemen and are, therefore, a menace to the city, but in answer to this there is the danger of having the service switch fuses and connections in the cellar, which is generally filled with inflammable material, boxes, papers, and so forth, as we all have seen. Another source of danger which is not always remembered is the possibility of a service fuse blowing out, when it then becomes necessary to carry a light of some kind through the cellar to reach the switch. In order to reduce to a minimum the danger of fire, it is essential that a service switch should be located in some accessible place, and cellars are generally blocked with boxes and barrels, and in case of emergency very difficult to get through. There is one more source of danger from the underground system, and that the chance of explosion of gas in junction boxes and manholes, and I don't think any system yet developed has entirely obviated this danger.

Boston Edison Company Discusses Earnings.

At a hearing before the Massachusetts Gas and Electric Light Commission, Sept. 30, the Boston Edison Company presented an extended statement through its counsel, E. W. Burdett, in reply to the inquiries of the Public Franchise League whether the company's total income is proper, and whether it is properly distributed among the different classes of customers. Mr. Burdett's statement was divided into three parts. The first part gave the company's reasons why its income is a proper one, making numerous comparisons with other companies in the United States and Great Britain. These statistics showed that the present income is fully justified. The second part was a discussion of reasons why the present method of apportioning the income among the customers is correct. This consisted of a historical review of methods of charging, a discussion of the maximum-demand system and the universal use of differential rates. The company argues that it is not the customers paying the maximum rate of 15 cents who make the profits for it, but that the profits come from the customers who pay 10 cents per kw-hour or under. The third part stated that present conditions are abnormal, owing to the effect which will be produced by the introduction of high-efficiency lamps. These lamps are expected to produce a reduction for the consumer now paying 15 cents, the equivalent of a decrease twice as great as would be effected by an alternative rate of 10 cents per kw-hour. The company suggested that any change in the kw-hour charge be postponed until the effect of the new lamps is ascertained.

Reviewing the main question at issue, Mr. Burdett said: "Regarding the distribution of costs among customers, our theory recognizes classes rather than individuals. All individuals taking current under the same conditions receive exactly the same price, which price bears a definite relation to the cost of serving those in that particular class. The classification of these costs is that common among all the electric lighting companies, and has already been explained in the answers submitted to the board earlier in the year.

"We have pointed out that at least 80 per cent of the income of the company is required to pay expenses depending more upon the size of the customer than upon any other factor, the remaining expenses being dependent upon the kw-hours sold. Hence, if the first item is apportioned among the customers in proportion to their size, and the second item in proportion to their use, much greater accuracy of cost distribution is secured than under any other known method of charging.

"As to the allegation that the relative cost of the Edison Company's plant and property is much higher than in certain other cities—New York, Chicago, Worcester, Salem, Lowell, Cambridge, Fall River and Lynn—this claim does not conform to the facts. As far as we have information, it is not true of Chicago. Statistics show that it is not true of New York; and that as to the Massachusetts cities named, it is not true when underground investment and the higher price of land in Boston are considered, as well as the absence of distribution investment in those cities where power is supplied to railways.

"As to the relative higher cost of management of this company, as compared with certain other Massachusetts companies, after taking into consideration the excess of our taxes and of our 'New Business Department,' this statement is true only within very narrow limits. This excess of management excess is offset nearly four times over by the saving in generating and distribution expenses; so that the total operating expenses even considering these taxes and the 'New Business Department' are as low as those of the other Massachusetts companies named.

"The benefits derived by the community from our acquisition of other electric lighting plants consists in the distinctly lower costs of electricity as a consequence of these purchases, not only in the districts acquired, but throughout the company's whole territory. The prices paid for these plants were not excessive. Regarding the comparison of the maximum price charged for electricity by this company and certain other companies named by the petitioners as having a lower maximum price, it has been impossible to obtain the necessary facts from all of these cities. The two following reasons will doubtless cover the majority of cases; first, either the investment in these cities is lower than ours, largely on account of the difference in underground investment, or the return on the investment is less than a fair return; second, that while the maximum price in some of these cities may be lower, the average net price to the retail consumer is higher than ours.

"In the case of New York, to which neither of these reasons apply, we would call attention to the fact that the New York Legislature at the time of fixing the New York price at 10 cents, fixed the price in Brooklyn at 12 cents, and considering the comparative sizes and conditions of the three cities, it is fair to assume that had they at the same time been fixing a rate for the city of Boston, they would have made it 15 cents. It is important to note in this connection that the legislative act which fixed the minimum rate of New York at 10 cents and in Brooklyn at 12 cents, and would have given Boston 15 cents, resulted in an average rate to retail customers in New York and Brooklyn of substantially 10 and 12 cents, respectively, whereas the net average rate to retail customers in Boston is actually well below 12 cents, and not 15 cents.

"As to the statement that the Boston Consolidated Gas Company is able to charge a lower maximum rate for gas than the companies in many of the above cities, there is nothing in common between gas and electricity other than that they are both available for light, heat and power. Generally speaking, there is not the difference in the cost of street construction between large and small cities which exists in the electric lighting business, gas companies all being underground, regardless of the size of the city, whereas electric light companies may or may not be underground.

"As to the sliding scale, the company is in thorough sympathy with the principle, and while there seem to be some difficulties in adapting it to the electric lighting business, these can possibly be overcome. A definite plan has not been suggested, as a basis can only be determined upon on consultation with the board. It is impossible to measure the effect of a 10-cent per kw-hour alternative rate at this time on account of the complication of the situation by the introduction of high economy lamps."

Inauguration of the New York Edison Lecture Course.

For the benefit of its employees the New York Edison Company has inaugurated a course of lectures on electrical engineering to be delivered weekly at its auditorium, 44 West Twenty-Seventh Street, throughout the coming fall and winter. The first lecture was given on Tuesday evening, Oct. 1, to an interested audience which taxed to the utmost the seating capacity of the spacious auditorium.

Mr. Alexander Maxwell, chairman of the Lecture Committee, called the meeting to order and introduced Mr. John W. Lieb, Jr., who spoke on behalf of the management of the New York Edison Company. Mr. Lieb, in his opening remarks, dwelt on the deep interest felt by the company in the educational welfare of its employees, describing the successive steps in its welfare work, such as the building of the auditorium, the equipment of an employees' library and the institution of these experimental lectures.

Prof. Sydney V. Ashe was then presented as the lecturer conducting the course. In his address he emphasized the fact that there is an imperative demand for technical training in preparing to enter the engineering profession to-day.

The subject of his lecture was "Magnetism" and dealt with the fundamental principles governing the magnetic properties of iron. He laid great stress upon the necessity for a thorough knowledge of these peculiar characteristics of iron in order that the effect upon the growth of the electrical industry may be comprehensively grasped by the student.

Lantern slides and numerous experiments illustrated the

particular points of the lecture, which terminated at 10 o'clock. Prof. Ashe was assisted by Mr. C. S. Kern, of the Brooklyn Polytechnic Institute.

The Colorado Electric Light, Power & Railway Association's Question Box.

The Colorado Electric Light, Power and Railway Association, at its convention, in September, in Denver, conducted a question box which was taken up at various sessions. The following are some of the principal subjects and questions discussed, with the principal discussion they drew out.

BOILER AND ENGINES.

"Has lignite coal been successfully used on mechanical stokers?" brought the answer from Mr. John A. Beeler, general manager of the Denver City Tramway Company, that his company's power house had used mechanical stokers with lignite coal for several years, and obtained a better combustion than with hand-fired coal, resulting in a saving of probably 25 to 30 per cent in fuel. The load on the plant is fairly steady. Stokers would probably not be so successful in a small electric light plant with a poor load-factor.

The question, "How often do steam turbines have to be adjusted, and is the wear noticeable?" brought the answer from Mr. J. F. Dostal, superintendent of the electrical department of the Denver Gas & Electric Company, that his company had been operating the Parsons turbine for a year and without any perceptible wear in the moving parts.

"Are small compound engines preferable to high-speed turbines operated non-condensing?" brought the answer from Mr. Rogers, of the Westinghouse Machine Company, that a small compound engine would show greater steam consumption than the turbine.

"In steam turbine operation, what is the economy gained by superheating?" brought the reply that the saving is about 1 per cent for each 10 deg. of superheat up to 100 deg. superheat, and about 1 per cent per 5 deg. above that. It does not pay to superheat over 150 deg.

TRANSFORMERS AND LINES.

"What has been the experience of companies in grounding their secondary systems?" Mr. J. C. Lawler, of the Colorado Springs Electric Company, said that with the neutral grounded on a three-wire system, leaks in the customers' wiring would sometimes cause the meter to register. Mr. R. P. Bache, of Colorado Springs, said that a company ought to ground all secondaries. This question had been brought up in the National Electric Light Association time after time, and all authorities recommended it as an important safeguard. The question was raised whether transformers were more likely to be burned out by lightning with the secondaries grounded. It was said that at Manitou the company was losing many transformers when secondaries were grounded. Mr. Bache said that the Manitou plant did not have good lightning protection. One member said that the interests controlling the Public Service Company of New Jersey and those of the United Gas Improvement Company had ordered all superintendents to ground secondaries. He had not believed in it at first, but found no evil effects. A water-pipe system was usually the best ground to be obtained in Colorado. A pipe driven into the ground was satisfactory in a wet, clay soil, but was not likely to give a good ground in Colorado. Mr. R. T. Rossi, chief engineer of the Northern Colorado Power Company, told of an effective lightning arrester ground his company had used the past summer. This consists of a copper disc, shaped like a dishpan, so placed in the ground that whatever water sinks down to it is caught and held in the pan.

"Is it safe to work with the wires of a three-phase circuit of 13,200 volts when the line is dead with a live circuit of the same voltage on the other side of the pole?" Mr. Bache said that this was done in the East. The men wore rubber gloves and rubber boots. The line worked upon was short-circuited. Mr. Clark told of handling a 12,000-volt live line. Mr. J. R. Cravath said that on a 33,000-volt line in southern California, where there were two circuits on one pole line, it was the regular practice to change poles and renew insulators without interrupting the service.

"What are the relative merits of 'carbolinium,' 'antiseptine' and creosote oil for preserving poles?" Mr. G. R. Hall, of Westinghouse, Church, Kerr & Company, said he had used considerable carbolinium on poles. It was applied hot. The workmen had to cover hands and face, as when handling the hot liquid the fumes would affect the skin. It was applied on the pole butts up to 1 ft. above the ground. Mr. Rossi said that in some recent construction work he had set aside a certain number of poles to be treated with carbolinium. It had been suggested that a hole be bored in the pole and that kerosene be poured into this hole until it saturated the pole. Mr. Mathews, of the Denver City Tramway Company, said that he had tried this by boring a 1-in. hole 12 ins. to 14 ins. deep. This was tried on a northwestern cedar pole and on a native Colorado pole. Only a small amount of kerosene soaked in during the six weeks. Mr. Buttles reported finding dry rot underneath the surface with carbolinium-treated poles. About 75 per cent of the poles were so affected. Mr. Hall said that he had had similar experience with tar.

"What is the smallest size soft-drawn insulated wire you use for overhead lines with spans of 120 ft.?" Some members reported satisfaction with No. 8 wire, and even smaller, in places where there was no sleet.

"What means have been taken to prevent persons from shooting and breaking insulators?" Mr. Rossi said that his company, on a new line, lost 145 insulators in 7 miles, within a short time. They had, therefore, placed a notice on every fifth pole offering $150 reward to any one giving information leading to the conviction and punishment of persons shooting at insulators. A reward of $250 was offered to sheriffs of counties who catch such persons. A similar advertisement was run for five weeks in all the local newspapers in the district covered by the transmission lines, and by properly presenting the matter to the local editors, the local newspapers printed editorials calling attention to the great loss and inconvenience caused a large number of people by interruption to service and the shutting down of industries operated from transmission lines. This had practically stopped the trouble.

Mr. Mathews said that the Denver City Tramway Company was much troubled by persons shooting at insulators. Signs offering reward had done some good.

"What is the best and cheapest method of insulating wires when they pass through trees?" Mr. J. C. Lawler, of Colorado Springs, told of a long wooden sleeve which he had used at some places where it was impossible to trim the trees.

Mr. E. P. Dillon thought the best way was to trim the trees. In one case the fire department had been called upon to enforce the trimming on the ground of preventing fires. In another case the trimming of trees in a city required an ordinance passed by the Council. The company's engineer went over the whole city with a professional tree trimmer. A list of the trees to be trimmed was drawn up and an ordinance for their trimming passed the Council. There was thus no trouble about the trimming.

"How can transformer oil be readily tested for moisture and impurities?" Mr. G. R. Hall described a method of testing with a spark-gap. A tube holding 200 cu. cm of oil was provided with adjustable brass knobs in the ends, set 150 mils apart. A step-up transformer connected with this spark-gap was supplied from a generator, the excitation of which could be varied to give different voltages. A light fuse in the primary circuit was used to blow and disconnect the transformer when the spark-gap broke down. He mentioned the method of dehydrating oil with lime. The method of testing for moisture in oil with a red-hot wire was not good. The theory was that the oil would hiss, due to the escape of steam when the red-hot wire was plunged into it; but, as a matter of fact, oil entirely free from moisture, would frequently hiss.

Power Supply for Fryeburg, Maine.

A new power plant will shortly be completed at Swan's Falls, in the Saco River, about three miles from Fryeburg, Maine. The fall of the river at this point is about 10 ft., and the plans include a dam 225 ft. long and 5 ft. high, and a smaller dam 30 ft. long and 10 ft. high; a 20 ft. x 40 ft. wood and iron power house, and two 300-hp water-wheels, with electric generators. Only one wheel will be installed at first.

The supply of water is practically unlimited, as the river channel is wide with high banks for five or six miles back from the power house site. Work on the dam was begun in June, 1907, and advantage was taken of the natural conditions. An island in the river channel forms a canal on one side, in which the small dam has been built, of concrete, the larger dam serving to turn the water toward the smaller dam and the penstock, which is over 300 ft. long. Energy will be distributed from the plant by the Fryeburg Electric Light Company, which supplies the villages of Fryeburg and East Conway, N. H. It is estimated that at least 600 horse-power will be available during the midsummer low-water period, and 1000 horse-power for the greater part of the year. It is hoped eventually to supply energy for manufacturing and for the Fryeburg Street Railway, which will probably be extended to the adjoining towns of Lowell and Chatham. If possible, the work will be completed by Nov. 1, but at present high water is delaying the work in the wheel-pits.

American Production of Tungsten.

In view of the growing importance of tungsten-filament lamps, the recent report on the production of tungsten in 1906 in the United States, made by Mr. Frank L. Hess, for the Geological Survey, is of unusual interest. The tungsten ores produced in the United States in 1906 amounted to 928 short tons, valued at about $349,000. The output for the year is a gain of 125 tons, or 15.56 per cent, in quantity, and of $89,191, or 29 per cent, in value, over the known production of 1905.

The noticeable rise in the price of tungsten during 1905 continued during 1906, and the production was stimulated accordingly. There was, however, a very great discrepancy in the prices paid for ore in various places, as there is almost sure to be when an article is produced spasmodically in widely separated and often little-known localities, while at the same time the market is limited and the isolated small producers have slight chance to become acquainted with buyers and market conditions. Prices during the year ranged from $5 to $9 per unit for the contained tungsten trioxide or, as it is often erroneously called, "tungstic acid." The market for tungsten ores is expanding and seems now to be almost as sure as the market for copper or other staple ores. Firms requiring large quantities of tungsten have had difficulty in obtaining sufficient supplies to guarantee future deliveries.

The greatest producing locality in 1906 was Boulder County, Col., but tungsten mining was carried on also in California, Arizona, Montana, New Mexico, and Washington. The Boulder County ore is wolframite, but the deposits in California are chiefly scheelite. No production of tungsten was reported from the deposits in Alaska, Connecticut, Oregon or Idaho, but considerable development work was done at Osceola, Nev. New deposits of scheelite have also been found at Murray, Idaho, where it is hoped that production will soon begin.

During the year, it is noted in the report, experiments that have been carried on for a long time produced incandescent lamps, the filament of which is made of metallic tungsten. Large quantities of sodium tungstate are manufactured, much of which is said to be used in fireproofing cloth for curtains, drapery, etc., and as a mordant in dyeing. Tungsten salts are also extensively used in silk manufacture, being added to the silk with the dye to give more apparent weight to the fabric.

CURRENT NEWS AND NOTES.

THE TELEGRAPH STRIKE has been called off by President Small of the Commercial Telegraphers' Union, and in several places the operators are seeking their old jobs, but meantime in Chicago the National Executive Board has suspended President Small and declared the strike still a fact. A greater welter of confusion it would be hard to imagine. The friends of the strikers are exhausted, and but for the sufferings of many of those who went out, the whole affair would seem to have degenerated into a howling farce.

TELEPHONE CONVENTION.—The annual convention of the International Independent Telephone Association will be held at the Coliseum, Chicago, on Jan. 21, 22 and 23, 1908. This date falls during the period of the third annual Electrical Show and in connection with the exhibit of other electrical lines the independent telephone manufacturers have arranged to make a large combined exhibit of telephones and telephone apparatus and will occupy the entire Annex, containing over 100,000 sq. ft. of floor area. This will be the largest and most complete exhibit of telephone devices ever held at any one time under such circumstances.

AUSTIN POWER DAM.—A special dispatch from Austin, Tex., of Oct. 13, says: "The contract between this city and the New York Construction Company for the rebuilding of the great dam across the Colorado River at this place has been signed. The structure will cost about one and a half million dollars. The original structure was washed away by a flood in the river several years ago. The dam will form a lake 30 miles long and ½ mile wide, and will afford power for a large hydraulic electric plant." It will be remembered that the city has already incurred enormous indebtedness and loss over the previous plant and dam that were washed away.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its next regular monthly meeting on Tuesday evening, Nov. 12, at 8:15 o'clock, in the building of the Engineering Societies, 29 West Thirty-Ninth Street, New York. The principal address will be made by Mr. Charles R. Pratt and will treat of features of construction and operation of the gearless traction electric elevator, which is being installed in the Singer and Metropolitan Life, New York's two latest and highest buildings. The paper will be discussed by engineers and architects from New York, Philadelphia and Chicago. It is expected that the subject will be very exhaustively treated from the view of the architect and the engineer. The members of all professions are cordially invited to attend.

WORK IN MANCHURIA.—According to a long and interesting report by U. S. Consul-General W. D. Straight, the Imperial Chinese telegraph administration has established offices throughout Manchuria. New lines have been constructed since the war, and although some opposition was offered by the Japanese military authorities to their crossing the line of the South Manchurian Railway this difficulty has been overcome. Wires formerly controlled by the Russians have, moreover, been transferred to Chinese hands, and the service, therefore, is now operating in all centers of importance except Antung. All offices accept English messages. At Mukden there are two telephone services, the public exchange operated by Japanese and the Chinese official line connecting the various yamens, police offices and government bureaus. The two systems are connected. The Japanese have a long-distance service along the railway lines from Dalny to Mengchiatun, with a branch to Newchwang, and a second between Mukden and Antung. Instruments are also in use at Liaoyang, Tieling, Antung and Tatungkou, having in all of these places been originally installed by the Japanese military authorities. The Chinese, however, have appreciated the advantage of this method of communication and propose to control their own lines.

SUBMARINE LIGHTING.—A patent has been issued to Mr. Leon Dion, of Wilkesbarre, Pa., on a means for installing electric lamps at the bottom of the harbor or similar channels in order to allow vessels to make their course at night or during fogs without delay.

LECTURES ON PRACTICAL ELECTRICITY.—A series of free public lectures on electricity, its principles and application, were begun at the New York Electrical Trade School, Tuesday evening, Oct 15, at 8 o'clock, in the lecture hall of the school at 39 West Seventeenth Street, New York.

BRITISH TELEGRAPHS.—The report of the British Postmaster General shows that the number of telegrams dispatched during the year was 89,493,000, against 89,478,000. The profit on the postal service was £5,071,255, or £143,756 less. The net deficit on working the telegraphs was £88,764 less at £652,055. The nominal profit on the telephone system was £451,787, most of which was absorbed by interest payments on a capital expenditure of £7,255,000 and by appropriations for depreciation.

TRANSATLANTIC WIRELESS.—According to a despatch from Sydney, N. S., Oct. 8, Mr. Marconi, in an interview, said: "I shall be ready on Oct. 15. I was speaking to Clifden yesterday, and to-day exchanged many private messages." The Marconi people at Clifden, says a London despatch, assert that recent highly successful daylight exchanges of messages with Cape Breton prove that they have succeeded at last in overcoming daylight transmission difficulties. They say that daylight work is now almost on a par with night transmissions.

CALIFORNIA ELECTRICAL DEVELOPMENT.—In 1902 a "California Promotion Committee" was organized to promote the interests of that state generally, and in particular to give encouragement to the establishment of new industries and to invite desirable immigration. Among the means to this end is the issue of a monthly bulletin, which is now in its fourth volume. The October number of this publication is devoted entirely to the electrical development in California, and includes descriptions of some of the more important plants, and a table giving a list of 106 California power stations generating electricity from water power, together with the horse-power capacity of each station.

A MODEST MILLIONAIRE.—It is stated from Hudson, Ohio, that because the town authorities permitted his name to be divulged to the public as the donor of $75,000 to $100,000 to be spent in constructing an electric light and water plant sewage system, James W. Ellsworth, millionaire coal operator, whose home now is in New York City, has withdrawn his offer. Mr. Ellsworth offered to pay for the improving of the village where he was reared, a poor boy, on condition that no one should know who furnished the money. He feared a deluge of begging letters. The name became noised about soon, and in a letter Mr. Ellsworth takes the town's officers to task and blames them for losing Hudson its chances to become a model village. Mr. Ellsworth is a director of the Postal Telegraph Company.

TELEPHONY IN CHINA.—Mr. I. Laing, superintendent of telegraphs in China, and Chow Tszchi, first secretary of the Chinese legation in Washington, visited Columbus, Ohio, recently to inspect the automatic telephone system of the Columbus Citizens' Telephone Company. They were the guests of G. R. Johnston, general manager of the company, and were entertained by him. They spent most of the day at the exchange. It is said that the Chinese government is considering the establishment of a telephone system, but the visitors would not admit that they were securing information for this purpose. They went on to Chicago to continue their investigations, however. Some years ago Burton Ferguson, a Columbus man, established an automatic system in Shanghai, and he is now traveling in China, Japan and portions of Siberia demonstrating the system.

TRADE PRESS FEDERATION.—The second annual convention of the Federation of Trade Press Associations was held at the Willard Hotel, Washington, last week, and was ably presided over by Mr. John A. Hill, whose strong and forceful address will be long remembered. His successor in the presidency is Mr. J. Newton Hind, of Chicago. At the banquet Postmaster-General Meyer made an important speech, promising that no change would be made in the rate of postage for publications—second-class matter—and outlining his whole plans as to postage, parcels delivery and postal savings banks. The third assistant postmaster-general, Hon. A. L. Lawshe, also made a most interesting speech as to postal ideals and policies. During the convention Mr. J. M. Wakeman served as chairman of the committee on nominations and Mr. T. C. Martin as chairman of the committee on resolutions.

THE LABOR UNIONS.—It is interesting to note that President James W. Van Cleave of the National Association of Manufacturers believes and freely confesses that the large majority of the members of labor unions are law-abiding, public-spirited men. It is also his belief that the incapable, unfaithful and corrupt leaders of unions are to blame for most of the labor troubles which have been and are being inflicted on the country. In an address recently delivered at Battle Creek, Mich., he said that all good citizens should unite in remedying the abuses which the labor unions have perpetrated. In order to supply the lack of apprentices which the labor unions have virtually abolished, influence should be brought to bear to have manual training departments attached to every public school of the primary grade in the United States, where boys from 10 to 14 years of age would learn to handle most of the tools used in the more important mechanical trades, and there should be established public industrial high schools open to boys who take the manual training course in the primary schools, and from these industrial high schools after a two or three years' course boys could graduate as first-class mechanics. This plan of making the education of the hand keep step with the education of the head, in President Van Cleave's opinion, would give the country more and better mechanics than the dead and gone apprenticeship system ever furnished.

TRUST CONFERENCE.—As already noted in these columns, the conference on Trusts and Combinations, which is to meet in Chicago from Oct. 22 to 25, will probably be the largest gathering of well-known people ever assembled in this country for the purpose of discussing trade combinations. The delegates are being appointed by the National Association of State Railway Commissioners, and by Atty.-Gen. Hadley of Missouri, the latter being chairman of the recently formed organization of attorneys-general. The first day of the conference will be devoted to the discussion of the regulation of trusts and combinations by the State and Federal Governments. In the remaining days of the conference corporations and their capitalization and control, the protection of investors and stockholders, the just and practicable limit of regulation by state and nation of combinations in transportation, production, distribution and labor, and the relation of labor organizations, employers' organizations, and the various farmers' organizations and societies to the trust question will be discussed. "Is the Tariff the Mother of Trusts?" is another subject that will receive much attention, and the discussion, it is expected, will be participated in by many of the best-known members of the American Protective Tariff Association and of the American Free Trade League. Another interesting topic on the programme will be presented for discussion by J. A. Everitt, the president of the American Society of Equity, a farmers' organization with a membership of more than 2,000,000. In his speech Mr. Everitt will discuss that organization's proposition to control prices of farm products. The White Paper, Trust and the "Labor Trust" will also be subjects handled by Herman Ridder, of the New York *Staats Zeitung*. Other well-known persons who are interested in the paper question will also probably be heard.

The Park Royal Generating Station of the Great Western Railway, London.

THE new electric supply system of the Great Western Railway has been installed partly to meet the requirements of the Metropolitan Railway Act, providing that the Hammersmith & City line, owned jointly by the Metropolitan Company and the Great Western Company, and also the lines of the Great Western Company used in connection with the Hammersmith & City Railway, should be operated electrically, concurrent with the electric operation of part of the Metropolitan Company's Inner Circle Railway. The new electrical system also provides for a supply of electrical energy for arc and incandescent lamps and for small motor work throughout the Great Western Company's system in the London district. For the past 23 years, the lighting supply of the Great Western station at Paddington has been provided by a generating station at that place which was equipped with low-pressure alternators of unique design. This historic installation has only recently been displayed.

The new system includes a main generating station at Park Royal and three sub-stations at the following points: Old Oak Common, Royal Oak and Shepherd's Bush. The distributing centers are situated as follows: one at each of the Royal Oak and Shepherd's Bush sub-stations, two at Old Oak Common, one at Westbourne Park station, one at Hammersmith, and the remaining five in the neighborhood of Paddington station.

The general arrangement of the generating station at Park Royal is shown in Fig. 1. The present station only occupies about one-sixth of the available ground, the idea being that when future needs warrant, another station can be designed to satisfy the then conditions, untrammeled by anything in the earlier station, and in the light of accumulated experience.

The main building is a steel structure, filled in with brick and roofed with glass and slate, the wooden framework for the latter being lined on the inside with fireproof plaster. The boiler house at the east end of the main building is arranged in three bays. Over the center bay is a set of steel coal bunkers having a total storage capacity of 600 tons. A main flue is built behind each row of boilers, and the two flues are joined outside the east end and are carried into the base of a chimney in such a way as to leave room for a connection to the same chimney of a similar main flue when the present station is enlarged to twice its size. A by-pass flue is also provided outside the east end of the boiler house. The flues are arranged so that connection can be made to a second chimney which will be built outside the northeast corner of the building when the station is extended.

To the west of the boiler house, and separated therefrom by a party wall, is the main engine room, which is likewise arranged in three bays, the two side bays taking the engine sets, and the center bay the condensing plant, which is also above floor level. The switchboards are arranged on galleries extending across the breadth of the engine room at the west end. The concrete foundations for the main engines and for the condensing plant leave five passages in the basement from end to end of the engine room. The three center passages and the space at the east end of the foundation blocks contain all the pipe lines. These passages and the space are separately drained and entirely shut off from the remaining two passages and the switchboard basement at the west end which accommodates the cables. Room is provided for a workshop and stores in an annex to the engine room. Coal is brought over a siding in 20-ton hopper cars, which empty into reinforced funnel-shaped concrete hoppers having a total capacity of about 400 tons of coal. Beneath these hoppers are two tray conveyors which carry the coal from any hopper to the bottom of two vertical bucket conveyors, which lift the coal about 50 ft. above the boiler-room floor-level and there deliver it to two horizontal bucket conveyors running into the boiler house and emptying into the main coal bunker. The same horizontal conveyors carry the ashes out of the ash pits and discharge them

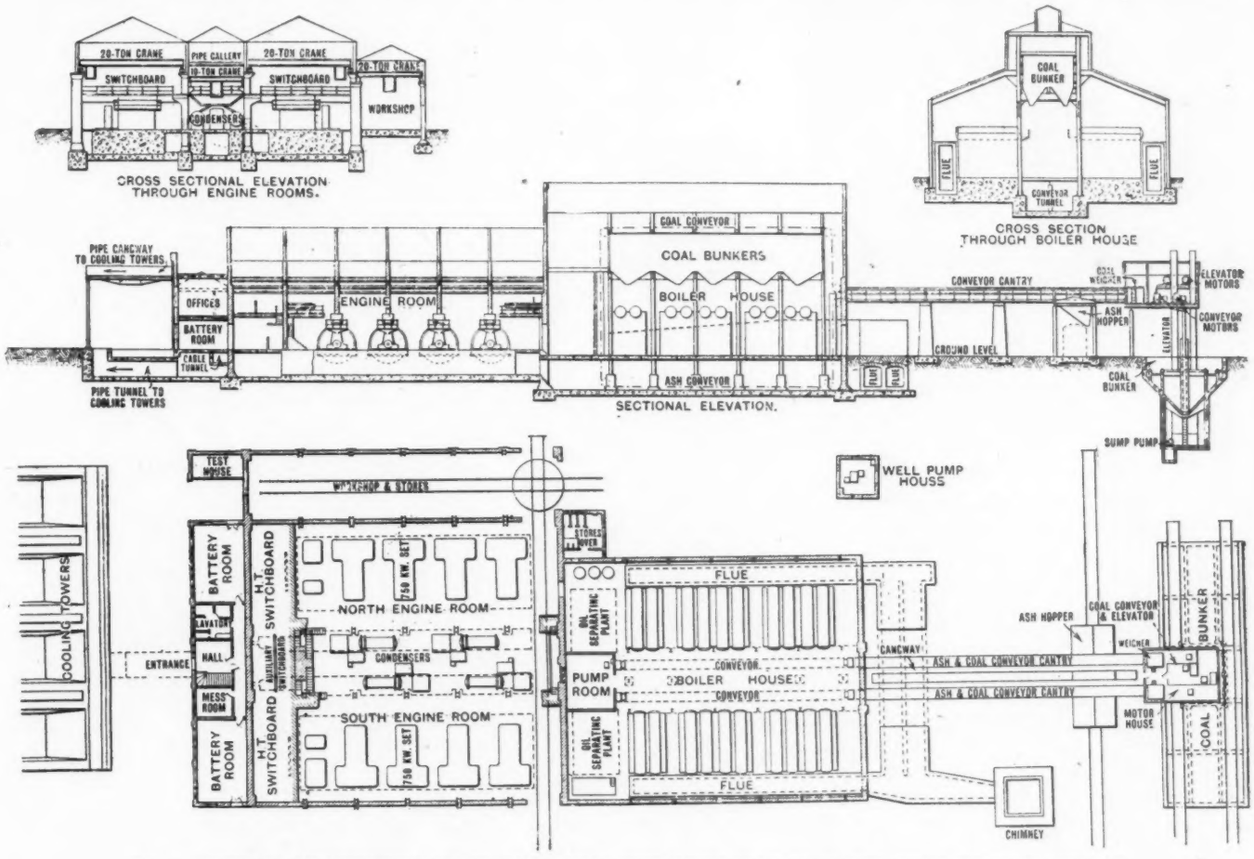


FIG. 1.—GENERAL ARRANGEMENT OF THE PARK ROYAL GENERATING STATION OF THE GREAT WESTERN RAILWAY.

into an ash-hopper, standing over railroad tracks. These conveyors are all driven by three-phase motors.

Water is taken from the canal at Old Oak Common, an alternative supply being obtained from the Water Board, and is delivered to the water tank in a yard outside of the west end of the engine room. From this tank, the water passes to the pump-room basement in the boiler house and is taken thence through two cylindrical drain-water coolers into the overhead feed tank in the engine room. The make-up feed water is supplied from this overhead tank through a water-softening

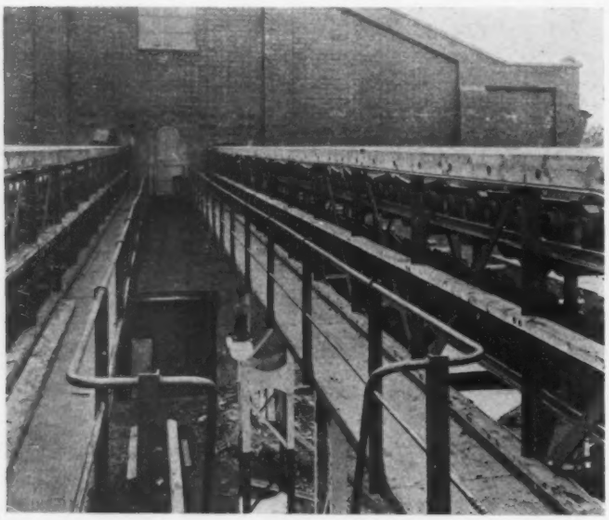


FIG. 2.—CONVEYOR GANTRY BETWEEN BOILER HOUSE AND DRIVING HOUSE.

plant into the hot-well tanks. The feed-water pumps are connected to the hot-well tanks and also to the main water-supply pipe, and deliver the water through meters and feed-water heaters to the boiler. The engines exhaust normally passes through mechanical oil-separators and into surface condensers, from which the condensed water is drawn by means of air pumps and delivered by force pumps to the inlet of an oil-separating and filtering plant at the west end of the boiler house, and thence to the hot-well tanks. The circulating water for the condensers is drawn from lodges under the cooling towers by centrifugal pumps, and after passing through the condensers is forced to the top of the cooling towers; make-up water being supplied from the water-supply tank in the yard.

The boiler-room equipment comprises 10 Babcock & Wilcox water-tube boilers arranged in rows along the walls. The coal bunker over the stoking floor does not obstruct light from the side roof glazing, so that the boiler room is light and airy. The boilers are fitted with chain-grate stokers, and the coal is delivered into the feeding hopper of each furnace through a chute from the coal bunker above. The boilers are fitted with superheaters and the tubes are divided up so that the circulation of the feed water is definite, passing first through a set of tubes intended to act as economizers. The feed-water pumps are installed at the engine-room end of the boiler house with the oil-separating and water-softening plant on either side. The main work of oil separation is done by mechanical oil separators placed between the engine exhausts and the condensers, and the last traces of oil are removed from the feed water by means of the "Davis-Perritt" electrical process.

The water, in being treated by this process, flows under and over a series of cast-iron plates fitted in a vat. Direct current passing through these alternate anodes and cathodes exercises a directive effect on the oil particles, the greater portion of which unite with the iron oxide formed on the anode plates and are precipitated. The remainder is buoyed up by the escaping hydrogen so that the oil is thus separated and the water is said to carry no trace of oil recognizable by analysis. The direction of the current is reversed from time to time when the instruments in the vat circuit show that the resistance has risen to a certain value.

In the pump room there are four vertical steam-driven feed-water pumps, each of which has a rated capacity of 6000 gals. per hour delivered against the working pressure of 200 lbs. per square inch. The make-up water can be supplied direct to the hot-well tanks from the supply main, but is normally pumped into the overhead tank in the boiler room. The inlet to the softening plant is controlled by a float in the hot-well tank below so that the quantity of make-up water is regulated automatically. The water-softening plant is arranged in duplicate, each part being capable of drawing 2500 gals. of water per hour. Lime and soda are used as the softening reagents. From the precipitating chamber the treated water passes upwards through a wood-fiber strainer and then through a filter bed of quartz sand.

The engine room contains eight main generating sets arranged in two rows, of four in each bay. In the central bay are four surface condensers with their air and circulating pumps. Each generating set consists of a Bellis engine, direct-connected to a three-phase, 50-cycle, 6300-6600-volt, alternator built by the Electric Construction Company. Each alternator has a rating of 750 kilowatts and an overload capacity of 25 per cent. The engines are of the three-crank, triple-expansion type. The governor is controlled by an electric motor from the main switchboard gallery, so that the speed of the engines may be easily controlled for synchronizing and also for adjusting the load between the sets running in parallel. An emergency valve, electrically controlled from the switchboard, is also fitted to each engine so that steam may be entirely cut off, if necessary. The generators are of the ordinary revolving-field type. The stationary armature is wound in open slots and is star connected, but the center point is not permanently earthed. Screws are provided for sliding the armature sidewise for inspection.

The main steam pipes are brought through from the boiler room in two lines and joined into a ring by cross piping at

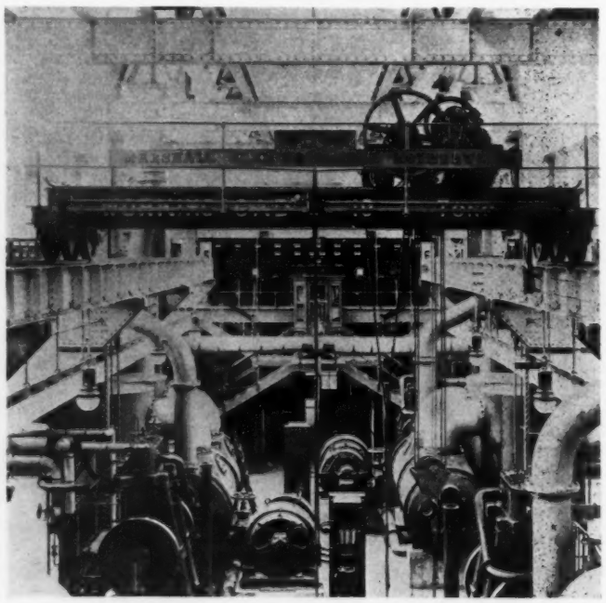


FIG. 3.—GENERAL VIEW OF CONDENSING PLANT.

the end remote from the boilers. Each of the condensers is capable of handling 42,000 lbs. of steam per hour. The air pump of each is steam-driven and the centrifugal circulating pump is driven by a three-phase motor. The circulating pumps can pass 178 gals. of water per hour. A general view of the condensing plant is given in Fig. 3.

There are four cooling towers of the natural-draft, wood type. Each tower can be divided into two sections, and under ordinary conditions of temperature can cool 145,000 gals. of

water 35 degs. from 115 deg. F. The cooling towers are 104 ft. long and 21 ft. wide at the base; the height from the base to the water inlet being 24 ft., and to the top of the tower 74 ft.

The western end of the engine room, between the main generating units and the switchboard, is occupied by auxiliary machinery for supplying direct current and low-tension three-phase current. Two exciter units are provided, one being steam-driven, and the other being driven by an induction motor. There are also two storage batteries used as a standby for

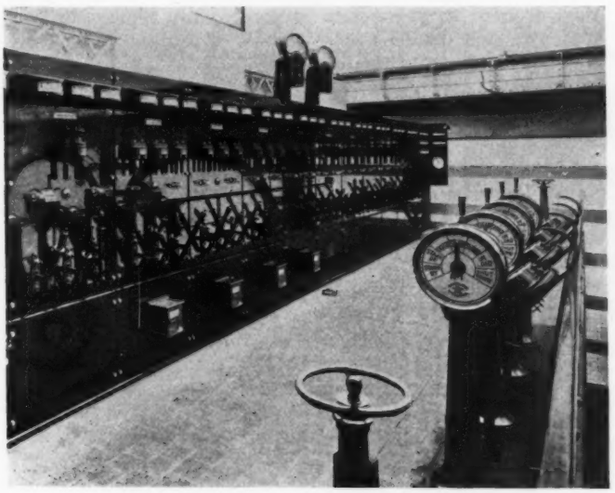


FIG. 4.—NORTH MAIN CONTROL BOARD.

excitation purposes. One of the three-phase generating sets is steam-driven, and the other is driven by a direct-current motor fed from the exciter bus-bars. It will therefore be evident that only by an extraordinary coincidence of breakdowns in different places can the station be deprived of energy for excitation and auxiliary motors.

The three-phase motors used throughout the station are supplied with current at a potential of 630 volts either from the low-tension alternators or from two sets of step-down transformers supplied from the bus-bars. The motor-driven three-phase generator can be used for supplying energy through the transformers mentioned or the set may be reversed for supplying direct current. The safeguards are thus rather complete and are made so by the various combinations of steam and motor-driven direct-current and alternating-current machines, rather than by duplication of apparatus. Each main engine room bay and also the workshop is equipped with a 20-ton traveling crane. The condenser bay is provided with a 10-ton crane. All of the cranes are equipped with direct-current, series motors.

From the main generators, the leads pass into tunnels under the engine-room floors and are brought into a cross-tunnel at the western end of the station under the switchboard galleries. The switch gear includes two high-tension switchboards for controlling the 6500-volt three-phase circuits, and auxiliary switchboard for controlling 650-volt, three-phase circuits, and two switchboards for controlling the 220-volt, direct-current circuits. The switchboards were supplied by the British Thomson-Houston Company. The high-tension part of each high-tension switchboard extends from the basement to a height of 33 ft., and consists of a steel framework filled in with stone slabs. Each circuit runs from the bottom to the top of the board and is separated from the rest by stone barriers. The switches, transformers, etc., on each circuit are further separated from each other by four horizontal partitions which divide the whole structure into a set of fireproof cells. Iron doors on each gallery give access to the individual cells so that each may be easily examined. The control board is placed on a gallery about 14 ft. above the engine-room floor and slightly in front of the high-tension portion of the switchboard. One of the main control boards is shown in Fig. 4.

Each main high-tension switchboard controls the four 750-kw main generators in the bay opposite which the switchboard is placed; three high-tension feeders; cables leading to an artificial load tank and some local branch circuits. The two main high-tension switchboards can be worked independently or can have their bus-bars connected for working in parallel. Each board has a duplicate set of main bus-bars and also a set of high-tension synchronizing bus-bars which are used in connection with the testing and charging of the feeders as well as for synchronizing the generators. Each set of main bus-bars is placed in a stone chamber with wire-woven glass sliding doors running the length of the switchboard structure in front of the switch cells. The main switches are mechanically operated from the control board. Advantage has been taken of the rodding system to interlock the switches by an adaptation of the railway signal frame lock so that a generator cannot be connected to one of the bus-bars unless the exciting and synchronizing switches of that generator have been previously turned to the proper positions. All of the instruments are placed on the control panels and are worked from transformers.

Immediately in front of the control panels are the main generator field regulating resistance columns, the engine governor and emergency valve switches; and also a set of signal columns and indicators by means of which the switchboard attendant can communicate with the engineers below. The circuit for each main generator or feeder starts in the basement in a cell containing a three-core cable sealing and dividing box to which it is connected by three-phase changing links. These links (Fig. 6) are arranged and shaped so as to enable any core of the cable to be connected to any one of the conductors of the switchboard circuit in order that the phases of a circuit may at any time be arranged correctly and symmetrically with reference to the phases of the other circuits, irrespective of the position of the cores of the cable in the box. Above the phase-

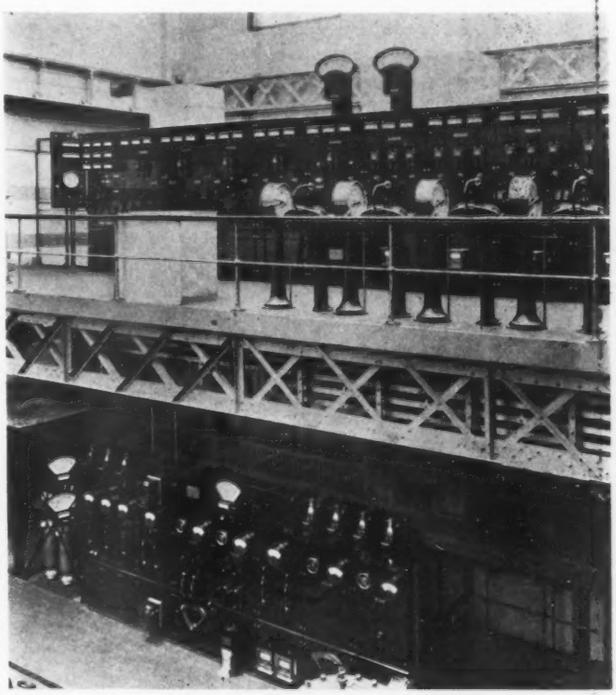


FIG. 5.—GENERAL VIEW OF SOUTH MAIN HIGH-TENSION SWITCHBOARD AND EXCITER BOARD.

changing links a set of disconnecting links is provided, which, when open, disconnects the cores of the cable from the switchboard circuit and connects them direct to earth. The links can be locked in the "open" or in the "earthed" position. On the cable side of these disconnected links, a set of glow tubes is connected to indicate when the cable is alive. The circuit is connected to three oil-brake automatic switches, the lowest

of which is directly connected to the synchronizing bus-bars, while the two upper switches connect to one or the other of two sets of main bus-bars. The main bus-bar switches are used as selector switches, and also serve as a standby to each other.

The generators or feeders may be changed from one set of bus-bars to the others through the generators' own switches or through a separate bar coupling switch. The necessary transformers for the instruments are connected on the cable side of the main switches and are also used to energize the instantaneous reverse and time limit overload relays used in connection with the main switches. Time limit overload relays are also provided on the main feeder circuits, the cables cross-connecting the two main boards, the bus-bar coupling circuits, the branch circuits, and the high-tension synchronizing selector switch feeder. The tripping relays are mounted on the front of the control panel and release the main switches by knocking out a link or toggle joint in the switch movement. Pilot lamps are used to indicate whether the tripping supply circuit is in working order or not.

A charge and test panel is provided on each main high-tension switchboard for the purpose of testing and charging the main high-tension feeders, either through water rheostats containing three-phase variable resistances or through the step-up transformers from the auxiliary 650-volt switchboard. The feeder-charging gear was supplied by Messrs. Ferranti, Ltd. The auxiliary three-phase switchboard for controlling the 650-volt alternating-current circuits is placed in line with and between the contact panels for the two main high-tension switchboards. The auxiliary board is equipped with two sets of bus-bars which may be coupled together when required. Each of the three-phase, 650-volt generators and the low-tension side of each set of

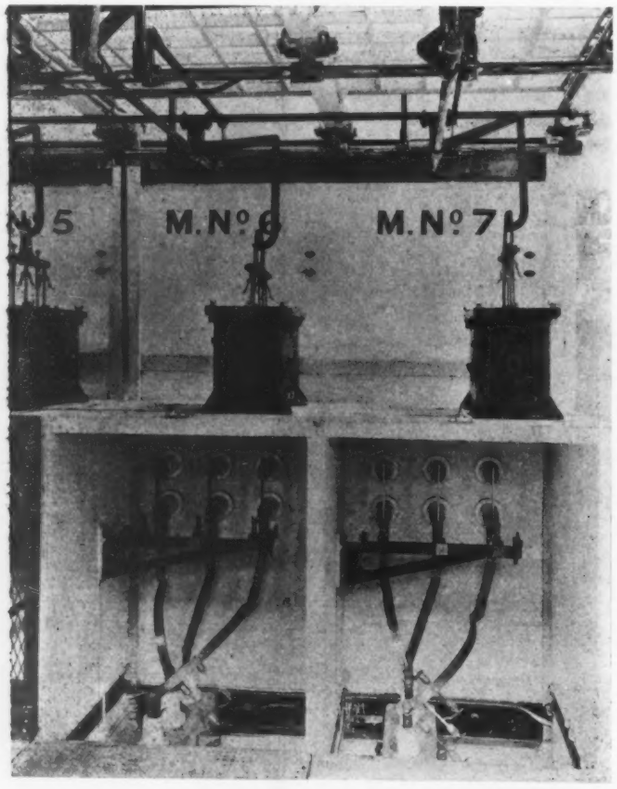


FIG. 6.—CELL IN BASEMENT, SHOWING PHASE-CHANGING LINKS.

step-up auxiliary transformers can be connected to either set of bus-bars through one or the other set of contacts of a special double switch, fitted with an overload release and an interlock between the two sets of contacts. The auxiliary feeder circuits supplying the various three-phase motors throughout the buildings are connected to the top set of bus-bars through switches with overload releases.

The two direct-current exciter switchboards or the ground floor can be worked separately or in multiple, and each controls one of the auxiliary direct-current generators, one of the storage batteries, three feeders for supplying the direct-current crane motors, and the arc and incandescent lamps of the power house, together with an excitation circuit for the main and auxiliary three-phase generators. There is no automatic protection between the exciter board and the exciter bus-bars, but a switch is provided with a discharge resistance and contacts, so that, if necessary, the excitation of the fields of the alterna-

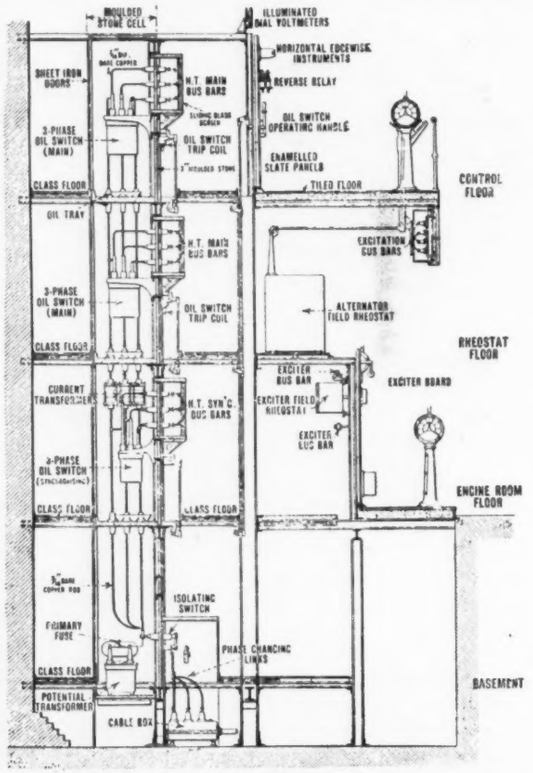


FIG. 7.—SECTION THROUGH GENERATOR CELLS OF SWITCHBOARD.

tors may be switched off collectively on the exciter board. In a shed outside the engine room are two tanks supplied with circulating water, each of which forms an artificial load corresponding to the output of one of the main generators.

Between the generating station, the sub-stations and the distributing centers are about 37 miles of high-tension, three-core cable, and about 14 miles of low-tension concentric cable, in addition to 4 miles of jumper cables. Each high-tension feeder between the generating station and sub-stations has three cores of .15 sq. in. sectional area, insulated with paper, lead-sheathed and armored with galvanized iron wire. The high-tension distributor cables are similar in construction. The low-tension direct-current and alternating-current cables are concentric, paper insulated and lead-covered.

The high-tension supply mains are led from the station to Old Oak Common along the railway. Each cable is laid in a separate Howard asphalt trough filled in with bitumen, and covered with asphalt concrete. Where they cross railway lines a concrete and brick trench is built, with old rails or steel troughing above to form a floor for the sleepers and rails.

At points where the cables are laid across railway bridges, the cables have been laid on steel plates fixed to the bridge girders, the ends of the plate being built into the concrete bed of the cable trench at each end of the bridge, but left free for a few feet between the bridge structure and the anchoring point so as to minimize as far as possible the effect of vibration.

All the laying and joining had to be done without interfering with the traffic, and great care had to be taken to avoid accidents. The usual method of jointing the cables was departed from, the last 20 ft. or 30 ft. of each length of cable being left unlaid until the end had been jointed to the next length. The

ends to be jointed were laid on a temporary platform placed over the trench protected by a jointer's tent. The continuity of the armoring at the joints is maintained by copper strips, clipped to the armoring beyond the wiped plumber's joint.

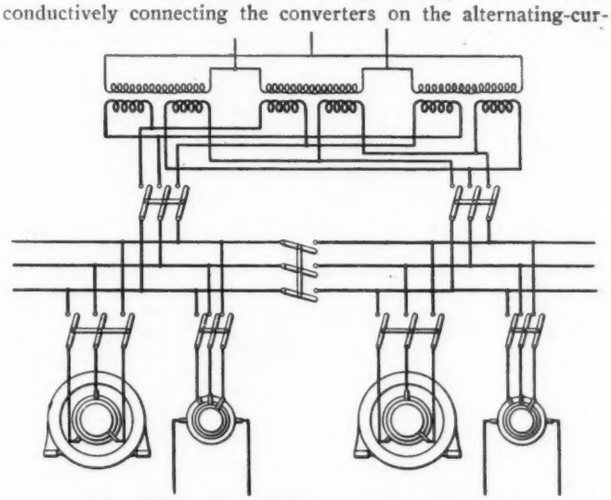
The three-phase current is transmitted from Park Royal by six high-tension feeder cables as far as an inspection chamber adjoining the sub-station at Old Oak Common. From this point five high-tension feeders are carried on to another inspection chamber at Westbourne Park. From Old Oak Common inspection chamber two high-tension feeders supply the Old Oak Common sub-station. From the Westbourne Park inspection chamber four high-tension feeders are carried to supply Royal Oak sub-station, and three to supply Shepherd's Bush sub-station.

The inspection chambers referred to are small brick buildings, into which the feeders are brought and terminated in trifurcating-boxes. The separate conductors are then led to sockets on vertical bars. The incoming and outgoing feeders are arranged along two walls of the chamber, and are normally connected by conductors taken up the walls and across the roof. But sets of horizontal bars crossing the feeder bars, and also socketed, permit of a certain amount of cross-connection by plugs between incoming and outgoing feeders, so that spare feeders on each side may be connected up as desired. The arrangements admit of the testing of every feeder or conductor.

The Royal Oak sub-station is equipped with four 400-kw motor-converter sets, worked in parallel with a battery having a one-hour discharge rate of 1680 amperes, in conjunction with reversible boosters. The sub-station also contains two 200-kw motor-converters for direct-current lighting circuits and for motor circuits. The Shepherd's Bush sub-station is equipped with seven 400-kw motor converters worked in parallel with a battery having a one-hour discharge rate of 840 amperes, in conjunction with reversible bootsters. The Old Oak Common sub-station is equipped with one 400-kw and two 200-kw motor-converter sets for direct-current lamp and motor circuits. All three sub-stations are designed on the same lines.

Inductive Paralleling of Rotary Converters.

The accompanying illustration shows a means for operating two or more rotary converters in a generating station without conductively connecting the converters on the alternating-current side, for which a patent was issued to Mr. L. C. Marburg on Sept. 24. The step-up transformers are provided with a plurality of independent low-tension windings adapted to be connected to bus-bars or to the converters. It will be noted that when the bus-bar sectionalizing switch is open each generator supplies energy to the step-up transformers and to a rotary converter, and yet the converters are not conductively interconnected on the alternating-current side and there can be no objectionable cross-currents between the converters.



INDUCTIVE PARALLELING OF ROTARY CONVERTERS.

Excitation Characteristics of the Synchronous Motor.

BY A. S. LANGSDORF.

Numerous contributions to the theory of alternator regulation have made it clear that a complete treatment of the subject must take account of a large number of more or less interdependent actions and reactions, such as armature reaction and reactance, variations of magnetic leakage with load, cyclic change of magnetic reluctance, etc. It follows that a like analysis of the synchronous motor must also take account of these disturbing factors, but the difficulties in the way of such an analysis are so considerable that it appears necessary to assume certain ideal conditions in order to arrive at reasonably simple results. In the following discussion of the synchronous motor it has, therefore, been assumed that the magnetic circuit of the machine is unsaturated, that the reluctance of the magnetic circuit and the armature reactance are constant (or that their variable values may be replaced by their averages) and that the m. m. f. of armature and field circuit currents may be combined vectorially. The extent to which these assumptions are approximate will affect the results given below in like measure.

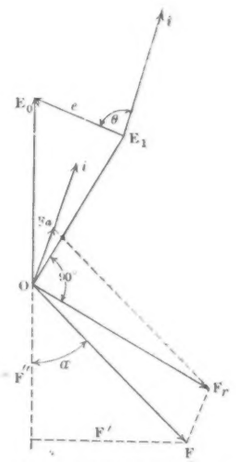


FIG. 1.—VECTOR DIAGRAM OF CURRENTS, E. M. F.S AND FLUXES OF SYNCHRONOUS MOTORS.

Fig. 1 represents diagrammatically the relations between the various quantities involved. It is drawn in such a way that counter-clockwise rotation is to be considered positive, and in consequence the complex expression for impedance is $r+jx$, instead of $r-jx$, as used by Steinmetz. The figure is similar to the one given in a recent paper* by Mr. B. T. McCormick.

Let E_0 = impressed e. m. f. at motor terminals
E_1 = counter-generated e. m. f. of motor
e = resultant e. m. f.
i = armature current
F_a = armature m. m. f.
F = field m. m. f.
F_r = resultant m. m. f.

Moreover, let r and x represent the effective resistance and reactance of the armature, respectively.

The essential condition of Fig. 1 is that E_1 shall be in time quadrature with F_r.

Expressed in complex quantities,

$$\dot{i} = \frac{\dot{e}}{r+jx} = \frac{\dot{E}_0 - \dot{E}_1}{r+jx} \qquad (1)$$

$$\dot{F}_r = \dot{F} + \dot{F}_a \qquad (2)$$

$$\dot{F}_a = k\dot{i} \qquad (3)$$

$$\dot{F}_r = -jm\dot{E}_1 \qquad (4)$$

where k and m are constants whose values are obvious.

*Effect of Armature Reaction in Synchronous Motors and Rotary Converters. Canadian Society of Civil Engineers, March 14, 1907.

Algebraic transformation and combinations of these four equations result in the following equations for E_1 and i:

$$\dot{E}_1 = \frac{k\dot{E}_0 + \dot{F}(r + jx)}{a - jb} \tag{5}$$

$$i = -\frac{jm\dot{E}_0 + \dot{F}}{a - jb} \tag{6}$$

where

$$a = k + mx$$
$$b = mr$$

The power developed by the motor is obtained by multiplying E_1 by that component of i which is in time phase with it (or in time phase opposition); or in complex quantities, by taking the real part of the product of $\dot{E}_1$ and the conjugate of i; that is, the power is

$$P = [\dot{E}_1 i']^1 \tag{7}$$

where i' is the conjugate of i.

Counting time from the instant when E_0 is at its maximum,

$$\dot{E}_0 = jE_0;$$

and noting from Fig. 1 that F is itself of the form

$$\dot{F} = F' - jF'',$$

there results the following expression for P on substituting values in (7):

$$P = \frac{aEF'' + b_0EF' - F^2r}{a^2 + b^2} \tag{8}$$

Treating the equation (6) in a similar manner, and rationalizing, the current is given by

$$i^2 = \frac{m^2E_0^2 - 2mE_0F' + F^2}{a^2 + b^2}$$

Referring to Fig. 1, it will be seen that

$$F' = F \sin \alpha$$
$$F'' = F \cos \alpha$$

hence, substituting these values in (8)

$$F = \frac{Q}{2} + \sqrt{\frac{Q^2}{4} - \frac{P(a^2 + b^2)}{r}} \tag{10}$$

where

$$Q = \frac{E_0}{R}[a \cos \alpha + b \sin \alpha] = \frac{E_0}{R}\sqrt{a^2 + b^2} \sin (\alpha + \Phi)$$

The value of Φ in the last equation is determined by the condition $\tan \Phi = \frac{a}{b}$.

Equation (9) becomes, after similar substitutions,

$$i^2(a^2 + b^2) = m^2E_0^2 + \frac{Q^2}{2} - \frac{P(a^2 + b^2)}{r} + Q\sqrt{\frac{Q^2}{4} - \frac{P(a^2 + b^2)}{r}} - 2mE_0 \sin \alpha \left[\frac{Q}{2} + \sqrt{\frac{Q^2}{4} - \frac{P(a^2 + b^2)}{r}}\right] \tag{11}$$

Equations (10) and (11) give the general values of armature current and field excitation in terms of a variable parameter, α, and the power developed; and from them may be drawn the usual "V-curves" by giving definite values to P, and for each value allowing α to take all possible values. Certain special cases, however, present features of general interest, and will be discussed in what follows.

Imposing the condition $P = 0$, representing the limiting condition of running light, (10) and (11) become

$$F = -\frac{E_0}{r}\sqrt{a^2 + b^2} \sin (\alpha + \phi) \tag{12}$$

$$i = \pm \frac{E_0}{r} \cos \alpha \tag{13}$$

The geometrical meaning of (12) and (13) is clearly seen

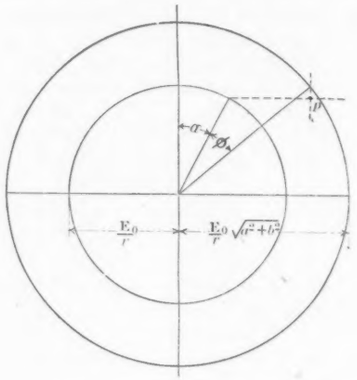


FIG. 2.—POLAR DIAGRAM OF EXCITATION AND ARMATURE CURRENT.

from Fig. 2, the significance of the parameter α being especially prominent. Evidently, the relation between F and i is repre-

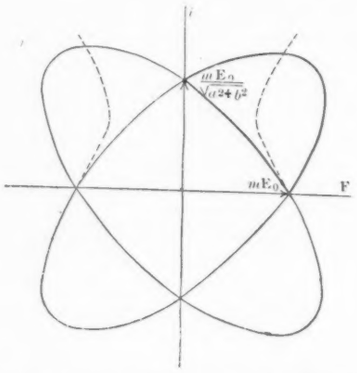


FIG. 3.—PHASE CHARACTERISTIC OF SYNCHRONOUS MOTOR.

sented by two ellipses, as seen in Fig. 3. The ellipses cut the axis of i where

$$i = \pm \frac{mE_0}{\sqrt{a^2 + b^2}} \tag{14}$$

and the axis of F where

$$F = \pm mE_0 \tag{15}$$

The maximum value of i (from (13)) is

$$i_{max} = \frac{E_0}{r} \tag{16}$$

and that of F is

$$F_{max} = -\frac{E_0}{r}\sqrt{a^2 + b^2} \tag{17}$$

Examination of (14), (15) and (17) will show that if $k = o$ (representing no armature reaction), these equations become identical with those derived by Steinmetz.

The maximum value of P (from 10) occurs when

$$P\frac{a^2 + b^2}{r} = \frac{Q^2}{4};$$

substituting the value of Q, there is obtained for this value of maximum power

$$P_{max} = \frac{E_0^2}{4r} \sin^2 (\alpha + \Phi) \tag{18}$$

but for any given value of F, P becomes a maximum when

$\frac{dP}{da} = 0$; from (8)

$$\frac{dP}{da} = \frac{-aE_0F\sin a + bE_0F\cos a}{a^2+b^2} = 0$$

hence $\tan a = \frac{b}{a} = \cot an\, \phi$, or $a = \frac{\pi}{2} - \phi$; hence (18) becomes

$$P_{max} = \frac{E_0^2}{4r} \qquad (19)$$

or independent of the value of k.

Minimum current at any given power is determined by the condition that the armature current must be in phase with the impressed electromotive force. Since the expression for the latter is $\dot{E}_0 = jE_0$, it follows that the complex expression for i must also be of the form $i = ji$; if now in equation (8) there is substituted for $\dot{F}$ its value $(F' - jF'')$, and the resulting expression is rationalized, there results

$$i = \frac{[a(mE_0 - F') - bF''] + j[aF'' + b(mE_0 - F')]}{a^2+b^2}$$

Hence, for in-phase current, it must follow that

$$a(mE_0 - F') - bF'' = 0$$

Substituting for F' and F'' their values in terms of a, and reducing,

$$F\sqrt{a^2+b^2}\cos(a-\phi) = amE_0 \qquad (19)$$

The real value of the armature current under these conditions is, therefore,

$$i = \frac{aF'' + b(mE_0 - F')}{a^2+b^2}$$

and on substituting for F' and F'' as before, this becomes

$$F\sqrt{a^2+b^2}\sin(a-\phi) = bmE_0 - i(a^2+b^2) \qquad (20)$$

Squaring (19) and (20) and adding,

$$F^2 = m^2E_0^2 + i^2(a^2+b^2) - 2bmE_0i \qquad (21)$$

Equation (21) represents analytically the curve drawn in dashed lines in Fig. 3. It is obviously a hyperbola. The coordinates of its vertex are $F = \frac{mE_0a}{a\sqrt{a^2+b^2}}$ and $i = \frac{bmE_0}{a^2+b^2}$.

The power corresponding to this point may easily be found by substituting these values in (10) and (11), and eliminating a; the actual value* of this particular power is thus shown to be

$$P' = \frac{m^2E_0^2a^2r}{(a^2+b^2)^2} \qquad (22)$$

Equation (22) gives that value of the power which corresponds to the minimum excitation consistent with unity power-factor. It is interesting to compare this value with the maximum power that the machine is capable of yielding (see equation 19). As an approximation, made for the sake of simplicity, assume that k is negligibly small, or in other words, that the armature magnetomotive force is small compared with that of the field winding; the value of a then becomes equal to mx, and on substituting this value in (22) there results

$$\frac{P'}{P_{max}} = \frac{4r^2x^2}{(r^2+x^2)^2} = 4\sin^2\Theta\cos^2\Theta = \sin^2 2\Theta \qquad (23)$$

where Θ is defined by $\tan\Theta = \frac{x}{r}$. Equation (23) shows very clearly that r must be small compared with x if the motor is to have large overload capacity under normal operating conditions (unity power-factor and moderate excitation).

*In deriving (22) the work is much simplified by writing (11) in the form $i^2(a^2+b^2) = (mF_0 - F\sin a)^2 + F^2\cos^2 a$.

Contact Method of Gas Engine Ignition.

BY E. J. EDWARDS.

In the design of a "contact" or "make-and-break" sparking equipment for a gas engine there are, from an electrical standpoint, four factors to be considered; electro-motive-force, inductance, resistance and time of contact; all of which are constant or nearly so for any given arrangement for igniting at constant engine speed. If these constants of the circuit are known the current, the energy stored in the magnetic field of the coil at the time of break and the efficiency with which this energy is stored can be calculated.

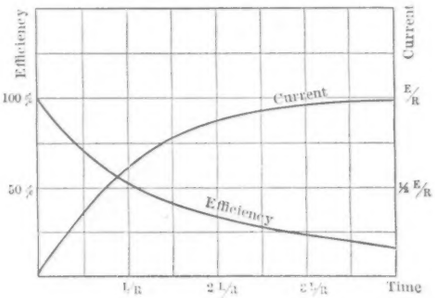
Let E = electromotive force, in volts.
L = coefficient of self inductance, in henrys.
R = resistance of the circuit, in ohms.
t = duration of contact, in seconds.
ϵ = base of the naperian system of logarithms = 2.718.

The current at any time, t, after closing the circuit is

$$I = \frac{E}{R}\left(1 - \epsilon^{-\frac{Rt}{L}}\right) \qquad (1.)$$

This equation shows that for a duration of contact of $L \div R$ seconds, the current at the time of break will be .632 $\frac{E}{R}$; which is true for all circuits. If time be measured in terms of the time constant $L \div R$ the rate of increase of current will be the same for all circuits, as shown below, plotted from equation (1).

Letting W = the energy stored magnetically at the end of t



RELATION BETWEEN THE CURRENT AND EFFICIENCY AND THE TIME CONSTANT.

seconds after closing the circuit of the coil and denoting instantaneous values by small letters, $dw = e\,i\,dt$ (2)
where e is the e. m. f. of self induction;

$$e = -L\frac{di}{dt} \qquad (3.)$$

From (2) and (3)

$$dw = -iL\frac{di}{dt}dt = -L\,i\,di \qquad (4.)$$

$$W = -\int_0^I L\,i\,di = -\tfrac{1}{2}LI^2 \qquad (5.)$$

The negative sign indicates that work has been done in storing the energy in the magnetic field during the time t, throughout which the current was increasing to the value I.

The efficiency of this process is the ratio of the stored energy to the energy given to the circuit in a given time. The latter can be determined as follows: The quantity of electricity in ampere-seconds Q passed through the circuit during the time t is proportional to the area between the current curve, above, the X axis and the vertical line through the time t. This

multiplied by the e. m. f. acting in the circuit gives the energy consumed, W'.

$$\text{Efficiency} = \frac{W}{W'} \tag{6.}$$

$$Q = \int_0^T \frac{E}{R}\left(1 - \epsilon^{-\frac{Rt}{L}}\right)dt \tag{7.}$$

$$= \frac{E}{R}\left(T + \frac{L}{R}\epsilon^{-\frac{Rt}{L}} - \frac{L}{R}\right) \tag{8.}$$

and the energy consumed is

$$W' = \frac{E^2}{R}\left(T + \frac{L}{R}\epsilon^{-\frac{Rt}{L}} - \frac{L}{R}\right) \tag{9.}$$

From (1) and (5) the energy stored is

$$W = \frac{E^2 L}{2R^2}\left(1 - \epsilon^{-\frac{RT}{L}}\right)^2 \tag{10.}$$

The efficiency is therefore

$$\frac{W}{W'} = \frac{\frac{L}{2R}\left(1 - \epsilon^{-\frac{RT}{L}}\right)^2}{T + \frac{L}{R}\epsilon^{-\frac{RT}{L}} - \frac{L}{R}} \tag{11.}$$

Letting $t = K\left(\frac{L}{R}\right)$, that is, expressing t in terms of the time constant, and substituting in (11) gives:

$$\text{Efficiency} = \frac{(1 - \epsilon^{-k})^2}{2(K + \epsilon^{-k} - 1)} \tag{12.}$$

This expression shows that the efficiency with which energy is stored in any magnetic field is independent of the constants of the circuit if the time during which the energy is stored is expressed in terms of the time constant. The efficiency when $K = 1$ is 54.3 per cent, and it falls to 22.1 per cent when $K = 3$; the complete curve, plotted from (12) being shown above. The efficiency of storing energy in the magnetic field of the induction coil will therefore be better the shorter the time of contact. The energy delivered to the spark will in general be different from that stored in the coil at the time of break. The energy of the magnetic field of the coil could be greater because some of the energy is lost in the iron and copper of the coil as the energy is given up to the spark. Again it could be less, due to the fact that the battery potential acts in the same direction as the e. m. f. of self induction and therefore aids in making the spark.

Little can be gained from a mathematical discussion of the spark energy because it would involve a knowledge of the resistance inserted in the gap during the time of break, which would vary, by some unknown law, from zero at the instant of release to nearly infinity at the time when the arc is broken. There is good reason to believe that, within working limits and for coils with properly built cores, the energy delivered to the spark does not differ greatly from that stored in the magnetic field of the coil, since the two unknown factors are of necessity comparatively small and have opposite effects.

In order to obtain experimental data with which to check the above deductions a running test was made on a fully loaded engine. The coil used was wound with No. 12 B & S copper wire, and had about a thousand turns with seven taps arranged so that various inductances could be obtained up to .27 henry; which range is greater than is used in practice. A battery of seven 2½ in. x 6 in. dry cells was used as a source of energy. The sparking mechanism of the engine was remodeled so that the time of contact could be varied without changing the time in the engine cycle at which release would take place. This gave a test with three variables; inductance, e. m. f. and the duration of contact. The object of the test was to ascertain how nearly the results would conform to the above-discussed relations, and to determine the quantity of stored energy required to give perfect ignition.

The coefficient of self induction had seven values (.002 to .27 henry), the time four (.006 to .066 second) and the e. m. f. seven (1.5 to 10.5 volts). The engine was run under the several possible conditions, and the percentage of failure of ignition was noted.

The results show that the engine operated in general as would be expected from the theory. For each period of contact used the engine gave perfect ignition at a certain induction with a minimum number of cells. For a time of contact of .006 sec. perfect ignition could not be had with less than four cells while for a time of .066 sec. the engine ran perfectly with two cells with a range of inductance from .04 to .27 henry.

Table 1 shows the calculated stored energy for each value of the inductance, and the time, with the least number of cells which would give perfect ignition.

STORED ENERGY IN JOULES.

	Inductance in Henrys					
Time. Sec.	.27	.199	.132	.080	.041	.014
.0062.....	.0064	.0060	.0060	.0100	.0120	.0280
.0260.....	.0310	.0250	.0160	.025	.040	.063
.044	.051	.062	.090	.057	.085	.093
.066	.045	.056	.080	.100	.129	.168

One is forced to the conclusion that the efficiency of "unbuilding" is not constant, but varies in the same way as the efficiency of "building." The shorter the time and the higher the inductance the less the stored energy required. That the efficiency of "unbuilding" should become less as the inductance decreases is to be expected, because the resistance becomes large in comparison to the inductance and thereby causes a large resistance loss. The fact that the efficiency of "unbuilding" should decrease with increased time used is not so easily accounted for. This result is due partly to the fact that for the longer times polarization of the battery took place, with the result that the calculated value of the stored energy is somewhat too large; but this does not fully account for the difference. It must then be accounted for by the only other variable, which is the condition under which the break is made. With the sparking mechanism used, the circuit was opened by a hammer blow, which was hardest for that adjustment which gave the longest time of contact. Therefore the conclusion that, within the range afforded by this experiment, the slower the separation of the contacts the more efficient the spark.

The following facts must therefore be considered in the design of a sparking equipment. The shorter the time of contact the higher the inductance and the smaller the resistance, the more efficient is the operation of the system. Also, the shorter the time in terms of $\frac{L}{R}$ the higher the factor of safety: when t is less than $\frac{L}{R}$, if the engine speed should decrease the spark energy would be much increased; due to the increased period of contact. If t is much greater than $\frac{L}{R}$ the spark energy would in no case be much increased by a reduction of the engine speed and would probably be decreased in most cases due to increased polarization of the battery.

The decrease of the resistance of the system is limited by the cost of construction or by the size of the coil. The inductance is limited by the same considerations and also by the fact that a high inductance requires a high e. m. f. A high in-

ductance, therefore, involves a high battery investment so that the gain in efficiency is offset by the fact that the battery will deteriorate more from age than from use. If perfect ignition is to be obtained at the least cost per year, the number of hours per day that the engine is to run must be taken into consideration. When an engine runs only a few hours per day the electrical efficiency can be sacrificed in order to keep down the battery investment.

On the basis of battery tests and prices, in connection with the above conclusions, the following empirical formula for determining the most advantageous number of 2½ in. x 6 in. dry cells is offered.

$$n = .4 \times \text{hours per day} + 3 \qquad (13)$$

This gives 3 cells as the minimum, and 8 cells for an engine running for 12 hours per day. If the engine is to be run for more than 12 hours it is advisable to employ two batteries; each being in use half the time.

The inductance should be rather high in all cases; that is, higher than present practice, and never less than .05 henry. When a battery of few cells is used the time of contact must be made long, in order to have sufficient spark energy. When a battery with a large number of cells is used the period of contact can be made short, thereby maintaining the same factor of safety, but increasing the electrical efficiency.

The relation of the inductance to the time of contact can be obtained from equations (1) and (5).

$$W = \frac{L E^2}{2 R^2}\left(\frac{-\frac{Rt}{L}}{1-\epsilon}\right)^2 \qquad (14.)$$

where W is the value of the spark energy, taken from the above table, and multiplied by a factor of safety. The e. m. f. E for a dry battery is approximately 1.5 per cell.

$$R = r'n + r'' + \sqrt{LC} \qquad (15.)$$

where r' is the resistance per cell (about .16 ohm), r'' the resistance of the connections (about .2 ohm) and C is a constant depending on the size of wire used for the coil and the relative dimensions of the coil (1.85 for the coil tested). From this equation it is seen that for any assumed values of W and E, L bears a certain relation to t, but it cannot fall below a certain value. If the value of t is required to bear a certain relation to $\frac{L}{R}$ the possible minimum value of L is still further limited.

The above relations can be approximately maintained by expressing L and t as straight line functions of n, where n has previously been obtained from (13). Assuming a factor of safety of 3, the following empirical expressions are obtained.

$$L = (.04\,n - .06), \text{ in henrys.} \qquad (16.)$$

$$K = (1.45 - .15\,n) \qquad (17.)$$

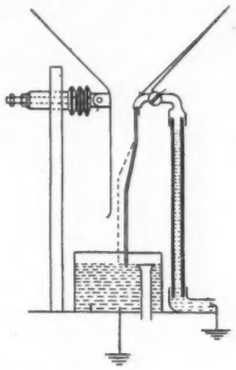
$$t = K\frac{L}{R} \qquad (18.)$$

For an engine running for 12 hours per day using a coil with $C = 1.85$ the following constants are obtained:

$n = 8$,
$L = .26$, in henrys.
$R = 2.65$ in ohms.
$\frac{L}{R} = .098$, in seconds.
$K = .25$
$t = .024$, in seconds.

Water-Jet Lightning Arrester.

In the water-jet lightning arrester shown herewith, for which a United States patent was granted to Mr. S. Schneider, of Berlin, Germany, on September 17, the connection to ground through the water-path is incomplete except when extra high potential exists on the transmission line. Thus there is no constant consumption of energy. The arrester is of the horn type the horn which is connected to the ground being formed in part by a jet of water supplied through an insulating tube. Statically charged water drops in the jet are attracted by means of the opposite charge on the high-potential conductor, and



SCHNEIDER WATER-JET GROUNDER.

hence when the charges are excessive the jet is deflected over against the conductor and a high resistance path is formed from the conductor to the ground.

The Grounded Neutral in High-Tension Systems.

At the meeting of the American Institute of Electrical Engineers, held Oct. 11, the subject of the grounded neutral with and without series resistance in high-tension systems was treated at length in a paper by Mr. Paul M. Lincoln. Papers relating experiences with the grounded neutral were presented by Mr. George I. Rhodes and Mr. F. G. Clark. Abstracts of these three papers are given below.

Mr. Lincoln showed that the following advantageous results accompany the use of the grounded neutral: The electromotive force between a conductor and the ground remains fixed and constant. Abnormal static induction on neighboring circuits is eliminated. Opportunity for using the ground as a working conductor is provided. It is possible to detect (and remove immediately if desired) a "ground" on any portion of the system. The condenser currents drawn from the several phases are rendered equal. Among the disadvantages were noted the following: One "ground" disables a part or the whole of the system. A proper "ground connection" is difficult to obtain.

Even where good engineering practice dictates a resistance in the neutral, the unavoidable resistance in the ground connection is not so valuable as it might be, because of its extreme variability. The difference of the seasons, as well as the drying-out action of any ground current that may flow, will cause large variations in ground-resistance. However, on high-potential systems the presence of even the maximum amount of resistance that is contingent upon good construction is rarely sufficent to cause trouble.

The object sought in "grounding" the neutral is to take care, not of normal conditions, but abnormal ones. It is the first thought of the operating engineer to maintain the service, and he therefore installs automatic circuit-breakers and other devices to protect the system in case an abnormal condition arises. The abnormal conditions that may arise are: 1, short circuits; 2, open circuits, and 3, "grounds."

With the neutral connected direct to earth, a "ground" on any conductor means a short-circuit; the action of automatic circuit-breakers will then take place. The amount of current that will flow through such a short-circuit can be limited by inserting resistance, and practically the only object of resistance is to cause such a limitation of current.

The flow of excessive currents, such as would take place were there no resistance, is detrimental for several reasons. It throws an unnecessarily great strain upon the circuit-breakers

which are called upon to interrupt the current. The large current-flow which takes place may cause a phase distortion and a drop in voltage which may, in turn, be sufficient to cause synchronous apparatus on the line to drop out of step. Almost invariably an arc takes place at the point of "grounding" of conductors, and an excessive current will cause excessive destruction at this point. A dead short circuit on any system causes a heavy shock due to the tremendous currents, and a consequent tendency to distort the windings of any synchronous apparatus connected to the system.

All of these objections can be overcome to a greater or less degree by inserting resistance in the neutral. Increased neutral resistance, however, while it limits the current flow through a grounded conductor, and overcomes the above objections, can do so only by allowing an increase in the potential of the two good conductors "above ground" while the current exists. If the object in "grounding" is to prevent such an abnormal rise, the insertion tends to defeat that purpose. The choice of the proper resistance becomes a question of compromise between the disadvantages of going to either extreme. There seem to be good reasons for adopting a "grounding" resistance which will lie between the following limits—that large enough to prevent a severe shock to the system, or the voltage on the affected phase dropping to a point where the synchronous apparatus will drop out of step and that small enough to permit sufficient current to flow to trip the circuit breaker.

In relating the experience of the Interboro Rapid Transit Company with the grounded neutral, Mr. Rhodes stated that the chief circumstance which led to the grounding of the neutral of the high-tension system was the serious nature of cable burn-outs. The system was operated for about three and one-half years without a grounded neutral, in which time about 160 miles of cable was operated for three years and 340 miles for one-half year. Since grounding the neutral, the system has been in operation for two years with about 340 miles of cable.

Previously to grounding the neutral, there were twelve distinct operating burn-outs, and since then there have been sixteen. It appears from this fact that grounding the neutral has had no material effect on the number of burn-outs. This is as was expected.

Of the twelve burn-outs occurring previously to the grounding of the system, four shut down the power station; one other shut down two sub-stations, and four more shut down one sub-station. Of the other three which did not shut down the sub-station, two were isolated in time to prevent a short circuit.

Of the sixteen burn-outs that have occurred since grounding the neutral, not one has caused a shutdown of the power station; eight have shut down the sub-station fed by the cable, two have caused one other feeder to open, and six have caused no disturbance other than the opening of the switches of the feeder in trouble.

Previously to the grounding of the neutral, the switches operated with explosive violence on the short circuiting of a cable, at times throwing oil and burning the contacts. Under present operating conditions, however, the switches always open very quietly, so quietly in most cases that it was necessary to install a telltale to indicate when there had been abnormal current through the neutral rheostats.

Before grounding the neutral, in all burn-outs the cable was so badly injured that it was impossible to make any bridge test, and it was necessary to open a great many manholes before locating the trouble. Of the sixteen burn-outs that have occurred since the grounding of the neutral, fourteen of them were in such condition that the fault could be easily located by the Murray loop method.

In the above system the neutral point of only one of the generators is connected to earth, experience having shown that when the neutral points of several generators are simultaneously grounded very serious trouble is encountered from triple-frequency cross currents in the neutral connections. Mr. Rhodes stated that probably something would be gained by increasing the resistance between the neutral and the earth connections. When the scheme was first contemplated it was planned to ground the neutral through six ohms, there being at that time only one power station. Now with two stations in parallel the effective grounding is through only three ohms, making the possible ground current twice that originally planned for. The use of the former resistance would have decreased the number of shutdowns of the sub-stations.

Mr. Clark stated that in a certain 11,000-volt system, a part of the circuits of which are aerial and a part underground, the neutral point of each generator is connected to a bus-bar through a fourth pole of the generator circuit breaker. The neutral bus-bar is connected to one end of a cast grid resistor suitably insulated. The other end of the resistor is connected to a ground plate located in earth kept moist with salt water. There is 6.7 ohms of resistance, or sufficient to allow 1000 amperes in the neutral circuit in the event of a "ground." A current of 1000 amperes will raise the temperature of the resistor by approximately 1000 degs. Fahr. in one minute. An ammeter on the switchboard indicates the amount of current in the neutral connection. A pilot lamp lights whenever 50 amperes or more flows through the resistor. This lamp remains lighted until an auxiliary circuit is opened, and has been instrumental in determining the number of short circuits that were also grounds.

During two years' operation there have been more than 70 short circuits. About 25 of these have caused sub-station interruptions, and six have been at locations near enough to the power station to cause power-station interruptions. About one-half of these short circuits showed a ground connection. There have been 10 "grounds," of which the neutral ground connection assisted in "clearing" eight. One held for four minutes and one for three minutes, both developing into two-wire short circuits. Although in case of a short circuit to earth the resistance of the ground path is sufficient to divert some current to neighboring telephone lines, no serious telephone troubles have been encountered, and there have been no indications of trouble in telephone or telegraph lines caused by induced potential.

A communication from Mr. F. G. Baum was read by Mr. Percy H. Thomas. Mr. Baum stated that experience has demonstrated that when the equipment has been properly designed and the insulation is ample, the system operates equally as well when delta-connected as when star-connected. For very high voltage work it is preferable, however, to use the star-connection, in which event the neutral can be reached without trouble.

A communication from Mr. O. S. Lyford, Jr., called attention to the great advantage of the Δ-connection, on account of the fact that the system can continue in operation with the transformers V-connected, when one of the transformers has been damaged. Moreover, when the Δ-connection is used without a grounded neutral, the system can be continued in operation when a single ground occurs on one circuit.

Mr. P. Junkersfeld related the experience of the Chicago Edison Company, which has in use about 270 miles of cable work. The neutral point of the system, in almost all cases, is connected solidly to ground. In a few cases, a certain amount of resistance is used. He expressed the opinion that it is advantageous to ground the neutral point.

Mr. Philip Torchio stated that the New York Edison Company has in use about 200 miles of cables, operated at 66,000 volts and at 11,000 volts. The neutral point is not grounded, yet very few troubles have been encountered. He stated that the only real advantage in using a grounded neutral is the assistance received in disconnecting the damaged circuit. That is to say, the safety devices may be made to operate more positively when a grounded neutral is used than when such neutral is omitted. The New York Edison Company has employed in connection with its ungrounded system a relay device for disconnecting defective circuits, which is believed to be equally as reliable as any device employed with grounded systems. The device consists of a circular transformer core, which is placed over the cable. When the condenser currents in the three-conductor cables are in the normal three-phase relation, there is no resultant m. m. f. in the surrounding iron ring. When, however,

there is a ground on the system, a certain amount of current which passes outward through one conductor of the cable does not return through the other conductors, but reaches the power house by some other route. Thus magnetism is produced in the surrounding iron ring. A coil wound on this ring is connected to a relay device which serves to open the circuit when the leakage current reaches a certain permissible maximum.

Mr. N. J. Neall discussed the bearing of the grounded neutral upon the lightning arrester equipment, and expressed the opinion that so far as the lightning arresters are concerned, a grounded neutral is of no real assistance. It is probably better to use a well-insulated delta-connected system without a grounded neutral.

Mr. C. W. Stone called attention to the fact that the difficulty in selecting a proper value for the resistance in the ground circuit, when several generators are connected in parallel, can be eliminated in part by using a separate resistance for the circuits of each generator.

The discussion of the papers was closed by Dr. C. P. Steinmetz, who remarked that practically every opinion that had been stated by one speaker had been contradicted in equally as strong terms by another speaker. This condition is attributable to the fact that each speaker discussed the problem from the viewpoint of his own system. What might be proper for one system operating under certain conditions would be improper for another system in which the conditions were different. Thus the solution of the problem would be entirely different for a system in which only cable work was used and a system in which only overhead transmission lines were used. He stated that in general it is preferable not to ground the neutral of a system unless the conditions are such as to necessitate such grounding. In former years, the general plan was to keep all parts of the system thoroughly insulated from ground. At the present time, the general tendency is to connect everything to ground that can be so connected. Dr. Steinmetz stated that it is usually good practice for the engineer when in doubt as to whether to use a certain scheme not to employ it if such scheme is in common use, because he unintentionally in most cases favors that side which is the fad of the time.

A New Mercury-Vapor Lamp in Competition with Arc Lamps.

A series of abstracts published in the Digest (Kuech and Retchinski, Jan. 19, 1907, p. 148; Arons and Kuech, July 13, 1907, p. 97; Bussmann, Sept. 7, 1907, p. 479) has given information relating to an interesting and novel development of the mercury-vapor lamp. From a paper read by Director O. Bussmann before the Berlin Electrical Society and published in the last issue of *Elektrotechnische Zeitschrift* it appears that the new lamp has now passed from the experimental into the commercial stage. In construction it is nothing more nor less than a mercury-vapor lamp; its distinguishing feature is that the tube in which the mercury arc plays is made of fused quartz instead of glass, so that it stands very much higher temperatures, while its properties and form render it a direct competitor of the high-candle-power arc lamp for general use.

Mr. Bussmann pointed out that if the curve of specific power consumption (with the watts per candle-power as ordinates and the watts as abscissæ) is plotted for the ordinary mercury-vapor lamp, this curve has a minimum corresponding to a specific consumption of 0.6 watt per candle. If the supply of power is increased, the candle-power increases to a less degree than the watts; in other words, the watts per candle increase. If this experiment is pushed so far that the glass tube containing the arc begins to soften, the lamp consumes about 1 watt per candle-power.

This observation was the starting point of experiments of Dr. Richard Kuech, engineer with W. C. Heraeus, in Hanau, a well known German platinum firm, which in the past few years has developed a line of fused-quartz apparatus for very high-temperature work in physical and chemical researches. As is now well known, fused quartz has the property of having practically a zero temperature coefficient of expansion, so that it may be heated or cooled suddenly without damage. It is, for instance, possible to pour cold water into a quartz tube brought up to red heat without danger of cracking it.

Dr. Kuech, who was acquainted with the possibilities of fused quartz, was led to the consideration that the increase of watts per candle-power with watts in the mercury-vapor lamp could certainly not go on forever and for certain theoretical reasons he concluded the curve of the specific consumption must reach a maximum somewhere, and would then come down to very low values. This conclusion was confirmed experimentally. With the arc playing in a quartz tube it was possible for him to raise the temperature very much higher than could have been done in a glass tube. A curve determined experimentally by Dr. Kuech, reproduced in Fig. 1, shows that the expected maximum is reached at about 1 watt per candle, and that afterwards the specific consumption decreases rapidly down to about 0.16 watt per candle.

It is instructive to observe what happens after the arc is started. In the new lamp, as in the ordinary mercury-vapor lamp, the tube is exhausted when cold. When the circuit is closed, the arc in the quartz lamp fills the whole tube, just as is the case of the ordinary lamp; but after some time the arc contracts into a thin line and not only does not increase in candle-power, but changes in color, the unpleasant greenish-

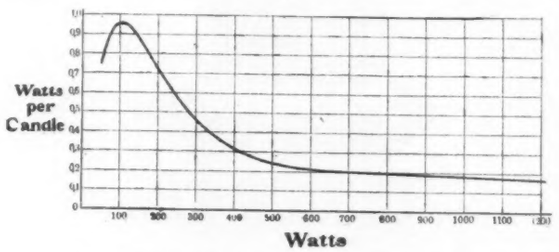


FIG. 1.—VARIATION OF SPECIFIC CONSUMPTION.

blue light of the mercury arc becoming a more pleasant yellow-white light. By a comparison of the spectra of an ordinary mercury-vapor lamp and the quartz lamp, it is found that the latter shows in addition to the well-known mercury line spectrum, a continuous spectrum, and the intensity of the latter increases with the watts. Moreover, the intensity of the different lines in this spectrum increases in a different degree. The yellow and red rays increase much more in intensity than the green and blue rays, and the lamp emits distinctly red rays.

In the ordinary mercury-vapor lamp the vapor pressure increases to about 2 mm. On the other hand, in the quartz lamp, when it is operated to its best advantage in practice, the pressure has gone up to about one atmosphere. For this reason the new lamp may be called a "high-pressure mercury-vapor lamp." For experimental purposes it is possible to push this increase of pressure still further, for instance, up to about 2 atmospheres, but in practice this involves dangers from escaping mercury vapor. For this reason the commercial lamp is operated at about 1 atmosphere pressure, or slightly less. For a vapor pressure of about 1 atmosphere the specific consumption is 0.2 to 0.25 watt per hefner candle-power, if the electrical power is measured at the terminals of the lamp and the candle-power in a direction perpendicular to the axis of the tube.

The third feature which strongly distinguishes the quartz lamp from the ordinary mercury-vapor lamp is that the arc is very much shorter. For this reason the dimensions of the tube are very much smaller. This will be seen from the following comparison:

	Glass Lamp 110 cm length	Quartz Lamp 8 cm length
Size for 110 volts.....	3 to 4 cm diameter	1 to 1½ cm diameter

For this reason it is possible to use for the new quartz-tube lamp fittings similar to those ordinarily used for arc lamps, the

new lamp being intended to compete with high candle-power arc lamps. Fig. 2 shows a quartz lamp for 3.5 amperes and 220 volts. The lamps for indirect illumination appear to be even more agreeable in form, as is seen from Fig. 3, which shows a 2.5-ampere, 220-volt quartz lamp in connection with incandescent lamps.

The quartz tube of the 3.5-ampere, 220-volt lamp (Fig. 2) is shown in Fig. 4. This illustration shows plainly two metal vanes at the two ends which serve for cooling purposes. The heat produced in the mercury poles is conducted away by these vanes and radiated. The size of the vanes regulates the heat removal and determines, therefore, the current which the lamp consumes after having reached the stationary condition. The quartz tube is movable around a horizontal axis and may be easily replaced. For lighting it the tube is automatically tilted on closing a switch by means of a shunt electromagnet, so that a thin stream of mercury flows from one end to the other.

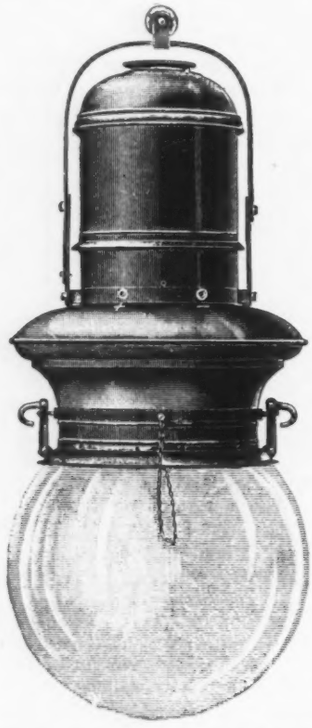


FIG. 2.—3.5, 200-VOLT QUARTZ LAMP.

When the circuit is closed, the shunt magnet will carry no current, and the tube, therefore, comes back to its normal position and the arc is started. Besides the tilting mechanism, the lamp contains the necessary resistance in series with the line connection. Since no further accessories are required and as the lamp can be operated singly at 110 volts or 220 volts, its installation is exceedingly simple.

In tests of the new lamp in the Reichsanstalt the results given in the following table were obtained. The volts represent the potential difference at the poles of the lamp (without series resistance). The amperes are the current through the lamp. The next column gives the candle-power in hefners, measured horizontally and perpendicularly to the quartz tube, followed by the mean spherical candle-power. The last two columns give the specific consumption in watts per hefner.

Volts	Amperes	Horizontal cp	Mean Spherical cp	Watts Per Horizontal cp	Watts Per Mean Spherical cp
174	4.20	3080	2680	0.24	0.27
197	4.20	3580	3110	0.23	0.27

If it is taken into consideration that the series resistance consumes about 35 to 40 volts, and that the light radiated upwards is sent down by means of a metallic reflector with a loss of not more than 50 per cent, there results, if all losses are included, a specific consumption of 0.25 watt per lower hemispherical candle-power if clear globes are used. For globes, frosted inside, the consumption is 5 to 10 per cent higher. For "opal globes" it is 20 to 30 per cent higher.

Simultaneously with the increase of pressure in the quartz tube, the resistance of the arc changes. Shortly after closing the circuit the tube consumes about 20 to 30 volts. If only

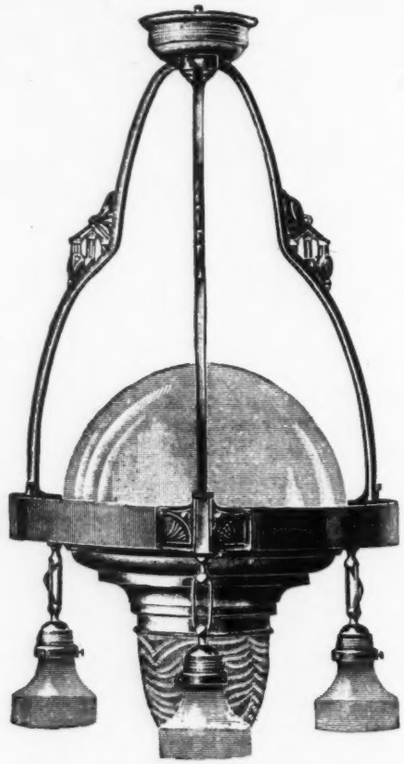


FIG. 3.—QUARTZ LAMP, WITH FILAMENT LAMP AUXILIARIES.

the normal current passed through it, the total normal watts (about 100 watts) would not be sufficient to bring the tube to the required high temperature. It is, therefore, necessary to pass in the beginning as high a current through the tube as practicable in order to arrive as quickly as possible at the high temperature. For this reason the series resistance is so designed that the initial current is more than double the normal current. A few minutes after closing the circuit the current

FIG. 4.—TUBE OF QUARTZ LAMP.

decreases, but the voltage increases until at normal current it has reached the normal value of 180 to 190 volts with larger lamps and 160 volts with smaller lamps.

The temperature within the tube is very high. A normal 180-volt lamp reaches a temperature of 1700 deg. C. when it is operated at 60 volts only. When it is operated at the normal voltage of 180 the temperature is estimated to be about 6000 deg. C. Since for experimental purposes the voltage may be

raised to about 250, whereby the pressure becomes 2 atmospheres, Mr. Bussmann thinks that the temperature then reaches the highest values which it is possible at present to obtain.

The price quoted for the 3 to 4-ampere lamps for 220 volts, which in energy consumption correspond to 12 to 16-ampere arc lamps, is about $50, including one quartz tube. The price of the smaller 2½-ampere lamp is $42.50. The high first cost of the lamp, in comparison with ordinary arc lamps, is due to the high cost of the quartz tube, for which up to 80 grams of fused quartz are required. The market price for fused transparent quartz is now about 25 cents per gram. It may be expected that ways and means will be found to decrease the cost of preparing fused quartz so that the quartz tubes which now cost singly from about $26 to $32.50 will also become cheaper. In spite of this high first cost, the quartz lamp will be found satisfactory even now for many applications on account of its long life and because practically no attendance whatever is necessary. The life of a quartz tube is guaranteed by the factory to be 1000 hours, but this is stated to be a low figure which is greatly surpassed by the results in practice.

Practically the only cost of operation—besides power cost—will be for replacing the quartz tubes by new ones. As mentioned before, this is after a use of 1000 hours, and then the charge for a new quartz tube is only $5, if the old quartz tube is returned, since it can be worked over again at the factory. It is stated that the Quartzlampen Gesellschaft, in Pankow, which manufactures these lamps, will put them regularly on the market during this autumn.

The new lamp is thought to be specially suitable for lighting extended railroad stations on account of the high voltage and the small attendance, and also for lighting workshops, parks and streets. Since for interior lighting the lamp yet lacks sufficient red rays, it is useful to combine it with ordinary incandescent lamps as shown in Fig. 3. Besides the visible radiation, the quartz lamp has a very strong ultra-violet radiation, which makes it useful for therapeutic work and also for photographic purposes, etc. For these purposes a special type of lamp has been developed.

Since the ultra-violet radiation is injurious to the skin and the eye, protection from the ultra-violet radiation is afforded by means of glass screens, which absorb this radiation completely. In the lamp as shown in the illustrations for general lighting purposes, this result is, of course, obtained by the surrounding glass globe.

Mr. Bussmann's paper was discussed at great length. Many speakers referred to the difficulty of making accurate photometric tests of such sources of light as the mercury arc, on account of its peculiar spectrum compared with ordinary sources of light. Other speakers claimed there was no difficulty in this case.

Dr. Norden pointed out that the new quartz lamp should not be compared with the ordinary mercury-vapor lamp with respect to its commercial applications. The ordinary mercury-vapor lamp is a source of light of medium intensity, say of, 300 to 600 candle-power, while the new quartz lamp has an intensity of several thousand candle-power, and is, therefore, one of the strongest artificial sources of light which we have. The ordinary mercury-vapor lamp is only adapted for interior lighting, while the new quartz lamp should compete with flame-arc lamps for strong light effects in streets, etc.

It was further pointed out by Dr. Gehrcke that while the new lamp contains red rays it does not contain them in great quantities, and its color cannot be called "beautiful." If an amalgam of zinc and mercury is used instead of mercury, the color becomes very much better, though the economy may be less. Mr. Wangemann suggested to put some highly refractory material around the mercury arc and by thus heating it to an enormous temperature produce a strong artificial light of the nature of the Drummond light. Mr. H. Heraeus replied that both these suggestions had been tried in his works, but had been found impractical. If a zinc amalgam is used instead of pure mercury, a combination spectrum is obtained for some time, but soon only the pure mercury spectrum survives. Any impurity has a bad effect on the life of the lamp. His firm, however, makes special lead-bismuth-zinc-cadmium-amalgam lamps as suggested by Dr. Arons. This lamp is excellent for spectroscopic purposes, but not suitable for ordinary illumination.

The Germans now make it a practice to compare arc lamps on the basis of the mean lower hemispherical candle-power. But it would seem that for the comparison of different types of lamps the only true criterion is the mean spherical candle-power.

It may, therefore, be interesting to compare this new German lamp with our ordinary arc lamps in this respect. Data introduced at the hearing in the Colorado Springs arbitration proceedings (Electrical World, April 27, 1907, v. 49, p. 821) indicated that "the maximum candle-power of the open 'full arc' is only about 1200 instead of 2000 as popularly believed, its mean spherical candle-power being 400 to 450, or about 1 candle-power per watt; while the usual 6.6-ampere enclosed arc gives only 150 mean spherical candle-power, corresponding to 3 watts per candle-power."

According to the Reichsanstalt tests mentioned above, the 4.20-ampere quartz tube lamp gave 2680 and 3110 mean spherical hefner candle-power, the voltage at the terminals of the quartz tube being 174 and 197, respectively. If we add 40 volts as lost in the series resistance, the voltage at the terminals of the lamp becomes 214 and 237, respectively, hence the watts 899 and 995. Since 1 spherical hefner candle-power equals 0.88 spherical British candle-power (if we use the older official ratio). the corresponding British candle-powers of the quartz lamp are 2358 and 2737. We therefore get for the specific consumption the figures 0.38 and 0.36 watt per mean spherical (British) candle-power measured without outer globe.

New Telephone Patents.

COMBINED JACK AND DROP.

E. J. Grenier, of Menominee, Mich., has invented a combined drop and jack. The shutter hook has its upper face shaped into a cam so that in rising it not only releases the shutter, but also gives it a positive kick outward. The falling shutter engages a lever, elevating it to close the right bell contact and also swinging its farther end into the plug channel of the jack thimble. The entering plug thus actuates the lever, its forward end coming down on the tube of the shutter. The shutter thus is lifted back home automatically.

DIVIDED SIGNALING AND TALKING CIRCUIT.

Except in the extremely short line house systems there has been little thought of dividing the signaling and talking circuits, it having been considered decidedly economical to make the same line and apparatus suffice for both in so far as possible. However, H. F. Joeckel, of Clayton, Ill., has now patented a system wherein if two line wires be provided, one is used to ring over to ground and the second to talk over to ground. There is nothing in the patent specification which shows where one could afford to use such a system in practice.

TRANSMITTER MOUTHPIECE.

In some classes of telephone instruments, the transmitter is placed with its edge to the user, the mouthpiece then having a right angle bend near its base so that its mouth will be presented to the user. With such an arrangement an adjustment of the height of the mouthpiece can be accomplished by swinging it in a vertical plane about its base as an axis. To this end R. Knoll, of Austria, has patented a special mounting for such a mouthpiece. This consists of a nipple having a flange midway its length and a split end, the nipple being attached to the transmitter. The metal mouthpiece has an expanded slit end which snaps off the flange, while the split tube engages its bore tightly.

SWITCHBOARD CIRCUITS.

Whenever cut-off relays have been used in connection with subscribers' line circuits, there has been found a disagreeable tendency to a loud report at the instant of operation. This is,

of course, due to the fact that within the limits of practical construction it is found impossible to prevent an abrupt change of the potentials impressed upon the line. Mr. H. P. Clausen of Chicago has patented an arrangement of circuits designed to reduce the click in the telephone. This comprises auxiliary contacts for the line relay by which, as it operates to display the line lamp, it also short-circuits the line. When the cut-off relay acts, the short-circuit provides a path for the disturbing currents. The short-circuit, of course, opens after the line relay is cut off. Mr. Clausen has assigned his patent to the American Electric Telephone Company.

In the accompanying Fig. 1 is shown the circuits of a two-wire system patented by E. E. Clement, of Washington, D. C. It will be seen that in the case of a call in, the lower relay responds to cut in the line lamp and also the upper or cut-off relay. This latter does not operate because of the resistance of the line or lower relay. Now when a plug is inserted, the coils in parallel with the line relay provide sufficient current to operate the cut-off relay. This clears the line relay and puts out the line lamp. It will be seen that the line relay must fall back slowly enough to enable the cut-off to act completely before the line relay begins to fall back. For an inward call, the insertion of a plug in the jack is of no effect until the subscriber answers. When this occurs the relays rapidly operate in succession.

An improvement in automatic exchange circuits has been patented by Mr. E. D. Fales, of Chicago. This relates to the release circuit, which during switching and conversation is maintained to prevent the apparatus from returning to zero or normal. It has been usual to arrange this circuit so that each machine involved in a connection controlled the release circuit of that machine subordinate to it until the last or connector machine. Now when a subscriber hung up, an appreciable time was required to restore the mechanism, as the first switch had to

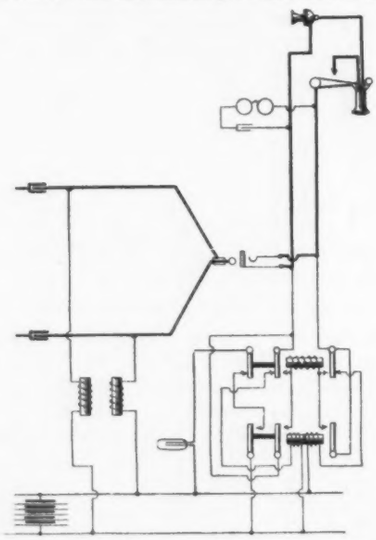


FIG. 1.—CLEMENT SWITCHBOARD CIRCUITS.

return clear to normal before releasing the second, and so on. In the present improvement the various release circuits are in series, so that at the first break of this circuit all machines involved start back home simultaneously. This patent has been assigned to the Automatic Electric Company.

INTERCOMMUNICATING SWITCH.

C. E. Lee, of Chicago, has patented an intercommunicating switch with an automatic release feature. An extension from the hook lever latches over the springs in a manner to secure them in the operative position until the receiver is returned to the hook. The springs are set in the operative position by push buttons.

SUPERVISORY CIRCUIT.

Supervisory lamp signals are almost universally included in local circuits controlled by relays in the main cord circuit. The number of relays required has varied from one to four, according to the arrangement of signals and the type of switchboard.

In Fig. 2 is shown a two-wire system in which no relays are required in the cord circuit to control the supervisory, this control being accomplished by the arrangement of relays and circuits of the line. The line relay serves in a dual capacity, its back and front contact circuits being controlled by the cut-

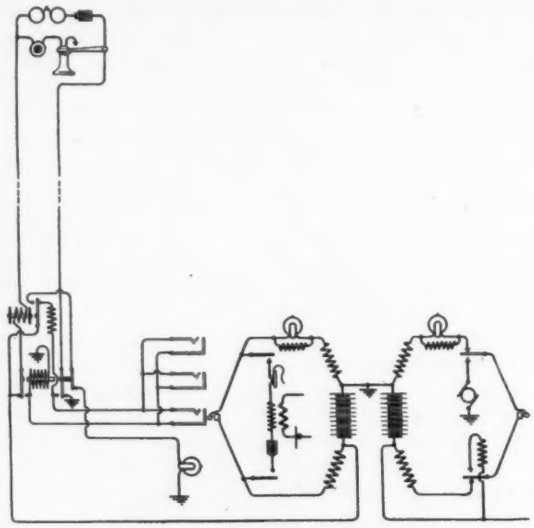


FIG. 2.—DEAN SUPERVISORY SYSTEM.

off relay. The supervisory lamp included in the talking circuit is so proportioned as not to glow for the talking current, but it will glow when an auxiliary low resistance path is provided by the dropping back of the line relay armature. W. W. Dean is the inventor of this circuit, his patent being assigned to the Kellogg Switchboard and Supply Company.

LETTER TO THE EDITORS.

Leakage Reactance of Induction Motors.

To the Editors of Electrical World:

SIRS:—In the issue of the ELECTRICAL WORLD dated Sept. 14, there appears a letter headed "Standardization of Scientific Notation," by Mr. J. P. Nikonow, in which reference is made to an article on "Leakage Reactance of Induction Motors," by the writer, printed in the ELECTRICAL WORLD, dated March 30, 1907.

In his letter Mr. Nikonow very kindly calls attention to certain errors and omissions in the article in question, which I should like to correct.

Mr. Nikonow remarks that the article is practically an abstract of Professor Adams' papers; this fact is mentioned in the article itself, where it is stated that the various formulas are practically those of Professor Adams, rewritten to make the computation easier. Professor Adams' paper states that in the case of motors with squirrel-cage rotors no belt-leakage exists; this is evidently incorrect, and in the article in question a formula is given for this leakage element.

In my article p represents the number of phases, and q the number of poles. The expression for the leakage of the end connections contains the terms:

l_1 = length of end connections per turn, in inches and $\log \frac{k_2\lambda}{d}$ where:

$k_2\lambda$ = the span of the coil, k_2 being the winding-pitch as a fraction of the pole pitch λ,

d_s = diagonal of the cross section of a phase-bundle, approximately equal to $\frac{\lambda}{p}$.

Expressed in terms of the machine dimensions, we get:

$$\log \frac{k_2 \lambda}{d_2} = \log \frac{k_5 \frac{\pi D}{q}}{\frac{\pi D}{q p}} = \log k_5 \, p$$

The expression for the belt-leakage (5) should contain S_0^2 instead of S_0.

General formula (6) is therefore correct with the exception that one half of the parenthesis around $k_0 + \frac{p_0 S_0}{p_1 S_1} k_1$ is missing.

The coefficient 20 applies to the slot leakage only; the whole of formula (6) is also expressed in inches, not partly in centimeters as suggested by Mr. Nikonow, as all the terms contain the factor 2.54.

The slot constant is exactly like Prof. Adams' and the multiplying factor 3.2 is contained in the factor 20 ($3.2 \times 2\pi = 20$).

$\frac{2h}{ag}$ should read $\frac{2d}{a+g}$; $\frac{t_{10}\, t_{11}}{2Q}$ should read $\frac{t_{10} + t_{11}}{2Q}$, and d should be δ.

I fail to see the advantage of retaining such expressions as π, 2π, $\sqrt{2}$, $\sqrt{3}$, etc., in a final working formula, which already is bulkier than desirable.

INDIANAPOLIS, IND. I. E. HANSSEN.

DIGEST OF CURRENT ELECTRICAL LITERATURE.

Dynamos, Motors and Transformers.

Series Single-Phase Motor.—R. RICHTER.—A detailed description of the series single-phase motor of the Siemens-Schuckert Company. The left hand diagram in Fig. 1 shows the original design. *A* is the rotor of the motor, *T* is a transformer, and the switch *S* serves for obtaining by voltage control the desired speed and torque. By means of *U* the direction of rotation is reversed by reversing the flux in the winding *E*. There are four stator windings, *E, K, N, H*. Winding *E* supplies the useful magnetic flux, while the three other windings, *K, H, N*, the axles of which are normal to that of winding *E*, serve for the following purposes: The winding *H* is placed on the commutating pole and the flux produced by it neutralizes the reactance voltage in the coils undergoing commutation. The winding *K* neutralizes the armature flux as far as distortion and reactance are concerned. The auxiliary winding *N* produces a flux which compensates "the e. m. f. at rest" in the armature coils short-circuited by the brushes. The right-hand diagram of Fig. 1 shows the new construction of the same motor; it will be seen that in this case the four windings of the former construction are replaced by a single winding by

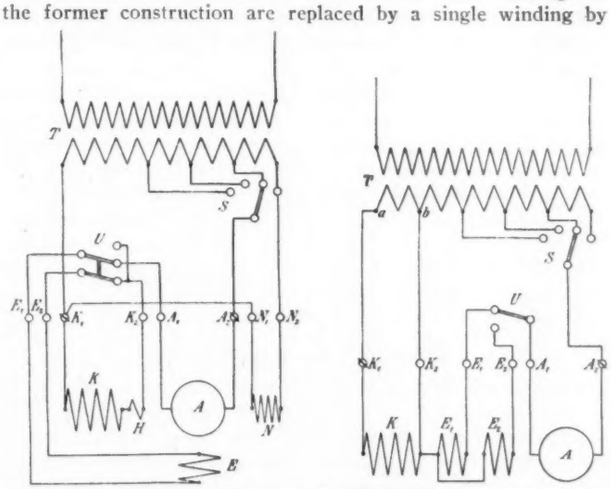


FIG. 1.—DIAGRAM OF CONNECTIONS OF SERIES SINGLE-PHASE MOTORS.

simply connecting K_2 to *d*, whereby *K* produces those results which were obtained in the former design by the three windings, *K, H* and *N*. It will also be seen that there is only a single-pole switch, *U*, necessary for reversing the direction of rotation of the rotor. The latter arrangement not only simplifies the construction, but the total copper losses are reduced. —*Elek. Zeit.*, Aug. 22.

Supplying Energy to a Direct-Current Three-Wire Network from a Single Dynamo.—E. J. BRUNSWICK.—An article illustrated by diagrams summarizing a study by C. C. Garrard on dividing the tension at the terminals of a single dynamo into equal parts by stationary arrangements, as in the three-wire dynamo of Dobrowolsky.—*L'Industrie Electrique*, Sept. 25.

Lamps and Lighting.

Lamps and Fittings.—An illustrated account of a very large number of accessories and fittings for electric lamps of British make, with some additional notes on heating apparatus and power appliances. Among the new lamps is mentioned the tungsten lamp of the British Westinghouse Company, which is suitable for alternating-current or direct-current circuits and has the same life in either case which is given at 1000 hours as a minimum. The specific consumption is one watt per candle-power. This lamp is supplied for constant-voltage circuits in sizes from 20 to 100 candle-power for from 50 to 125 volts. It is also adapted for series operation. Another British company is putting a metallic-filament lamp on the market for which a specific consumption of 1.2 watt per candle-power is claimed, with a useful life of 1000 hours. It is said to be equally suitable for alternating or direct current, and it is called the Metalik, although nothing is said concerning the nature of the filament.—Lond. *Electrical Review*, Sept. 27.

New Metallic Filament Lamp.—A note stating that a British company is now introducing a 50 to 60 candle-power, 100 to 130-volt metallic filament lamp, consuming 1 watt per candle-power. The lamp can be used only in a vertical position. The average life is given as from 800 to 1000 hours, with practically no decrease in candle-power. The lamps should be operated only in parallel. Their price is $1 each.—Lond. *Elec. Eng'ing*, Sept. 26.

Carbon Suspenders for Tungsten Filaments.—A note on the patent of the Deutsche Gasglühlicht A. G., relating to the employment of carbon in place of metal or refractory oxides for suspending the filament in tungsten lamps. The carbon-filament suspender is found to remain comparatively cool even when in contact with a white-hot metal filament, and can hence be made very thin. Although such suspenders cannot be used with osmium filaments, owing to the formation of a carbide, this objection does not apply in the case of tungsten filaments. —Abstracted from the British patent in *Science Abstracts*, Section B, Aug. 26.

Metallic Filaments.—R. JAHODA.—A note stating that all metalic filaments used in the new high-efficiency lamps—even those very thin, of about 0.02 mm diameter—are not solid, but are really hollow cylinders. This is the case with the metal not only in the finished filaments, but also in the raw state before formation. He describes a method for demonstrating this by microphotographs. It seems that the filament made from a plastic mass, when being dried, hardens first at the outside and the hardening action proceeds from the outside to the inside leaving a hole in the center. This phenomenon is to be taken into consideration when calculating the conductance from the diameter.—*Elek Zeit.*, Aug 22.

Arc Lamps.—A note on a British patent granted to Meyers for an arc lamp in which the feeding of the electrodes is controlled by the expansion and contraction of a thermal strip or wire. The lamp is provided with a contact on the lever, which is worked by the thermal strip. In the event of this strip becoming overheated, a contact is made which cuts it out of circuit.—Lond. *Elec. Eng'ing,* Sept. 26.

Flame Arc Lamp.—An illustrated description of a converging carbon flame arc lamp recently developed by C. E. Gilbert, in which a number of electrodes are arranged in a parallel group on both positive and negative sides. Only one pair of electrodes is used at a time, however.—Lond. *Elec. Eng'ing,* Sept. 26.

Power.

Power from Peat.—A review of a number of papers of Frank and Caro on the utilization of peat. Most attempts in the past have been in the direction of making fuel from peat, and many special machines have been devised for crushing, kneading, compressing and mixing the peat so as to render it suitable for fuel. Frank thinks, however, that such methods must always be restricted to certain localities where other fuels are expensive. Since peat is essentially an inferior fuel, there is no possibility of peat competing with coal in general. Another process for the utilization of peat is dry distillation and production of peat coke with by-products. A plant using the Ziegler process of this kind is in successful use in Germany. A third method of utilizizng peat is in gas producers for the production of power, also with the recovery of by-products. On the basis of the Mond process, Caro has worked out a new method for gasifying peat in a mixture of air and overheated steam in excess. One of the chief features of this process is that peat containing from 50 to 55 per cent of water can be used. Moreover, almost the total nitrogen contained in the peat is recovered in the form of ammonia, and can easily be worked up into ammonium sulphate, which is sold for fertilizing purposes. The gas produced is suitable for use in gas engines. The process is now tested in a large plant in the Mont Cenis mine in Germany. In a letter by A. Frank the importance of the subject for the United States is pointed out, and it is stated that his analysis of samples of peat from the United States and Canada have shown that there are in these countries large deposits of peat containing considerably more nitrogen than does European peat. The output of ammonia should, therefore, be correspondingly greater. The subject is also discussed in a long editorial.—*Electrochem. and Met. Ind.,* October.

Electricity from Blast Furnaces.—B. H. Thwaite.—An Iron and Steel Institute paper on the economic distribution of electric energy from blast furnaces. The great importance of using electric energy throughout any iron and steel works is pointed out, and also the objection which has been advanced against electric operation of rolling mills with the aid of gas power, namely, that a heavy expenditure is involved in such a technical reform. Only large companies can undertake it. The basis of the programme of the author is to pool the waste furnace gases from all the furnaces of an iron-making district independently of the ownership of such furnaces. The energy, electrically transformed, of the different furnaces would be transmitted to a central distributing and transforming station in which the e. m. f. is transformed to the value to satisfy different customers. The first call on this energy would be the satisfaction of the internal demands of the iron and steel works. The balance of the energy would be sold to outsiders. In case the blast furnaces should be shut down, it would be possible to get a satisfactory gas from a gas producer, which therefore would act as a standby, its cost being small.—*Electrochem. and Met. Ind.,* October.

Blast Furnace Gas.—J. von Ehrenwerth.—An Iron and Steel Institute paper describing a simple method for determining the total quantity of blast furnace gas for a given make and its calorific value, which can be utilized for power purposes.—*Electrochem. and Met. Ind.,* October.

Superheating.—O. H. Wildt.—The conclusion of this long, illustrated article on the use of superheat in electric generating stations, especially turbine stations.—*L'Industrie Electrique,* Sept. 25.

Traction.

British Municipal Tramways Association.—The first part of an account of this year's annual conference of the (British) Municipal Tramways Association, which was held in Manchester. J. M. McElroy in his presidential address pointed out that "in practically all the cities and towns in the United Kingdom the tramways have now been taken over and are operated by the municipalities, and that the benefits accruing to the traveling public, the ratepayers, and the tramway employees has been enormous. In the case of unrestricted private enterprises, such as are found abroad [United States], however, the undertakings are not up to the high efficiency to be found in many cities in England." Other papers abstracted, together with an account of the discussion which followed, relate to long wheel-base trucks by R. L. Acland, hours of labor and rates of pay by A. Baker, and staff organization by J. Dalrymple.—Lond. *Electrician,* Sept. 27.

Installations, Systems and Appliances.

Cost of Coal in Operation of Stations.—An editorial note on the effect which the threatened increase in the price of coal will have on the works cost. The effect may be quite serious in the case of gas companies, because the cost of coal consumed is more than half of the total cost, including capital charges, while in electric stations it may be as small as one-eighth, as for instance in Manchester. There are, however, cases in which the price of coal has considerable effect on the cost of electricity supply—namely, where the price per kw-hour has been based principally on running charges; that is, where it has been assumed that stand-by and capital charges are less important. As an instance in point, restricted hour supply is mentioned. In such a case the coal costs probably account for more than one-half of the total cost of supply, and it is advisable to insert in any agreement with such customers over a lengthy period a provision whereby the price charged per kw-hour would be controlled by the prevailing price of coal. In general, the higher the load factor, the greater is the effect of a rise in the price of coal and the more necessary is it to quote prices for electricity supply dependent upon a coal clause.—Lond. *Elec.,* Sept. 27.

Electricity on Board Ship.—The first part of an illustrated article on the electric equipment of the steamship *Mauretania,* of the Cunard Line, which is an example of the varied uses to which electric energy can be put on a modern steamship. In the present installment the system of energy distribution, electric generating plant, fans, motors for dismantling the turbines, cranes, lifts, etc., are described, while in the concluding article the lighting, refrigerating plant, the telephone installation, and the means adopted for measuring the power of the turbines will be dealt with.—Lond. *Electrician,* Sept. 27.

Wires, Wiring and Conduits.

Aluminum Cables.—An article on the aluminum cables which are to be used for the Loch Leven Power Company, in England. It will be the most extensive plant using aluminum cables in the United Kingdom. This power company is affiliated with the British Aluminum Company, which will furnish the aluminum. Owing to the position of the works, a tramway about 1¼ miles long is needed to bring materials from the wharf on the river to the power house. The trolley wire will be of copper, but the main and return feeders will be of aluminum. These involve some 500 yards of aluminum cable and about 2000 yards beyond this will be used in connection with the lighting of the tramway route, which will be carried out from the poles. For the lighting of the model village which is being erected for the workmen, the whole of the feeders and distributors will be of aluminum. Three thousand seven hundred yards of aluminum feeders, 4300 yards of distributors, and 1200 yards for house service will be needed. All

aluminum used in the stranded cables and other conductors is to have a conductivity of not less than 61 per cent of that of hard-drawn high-conductivity commercial copper. The tensile strength of the aluminum used in the stranded cables and other conductors is to be not less than 11 tons per sq. in., with an extension of not less than 4 per cent in 5 ins. The sectional areas of the finished cables vary between 0.899 sq. in. for the feeders to the factory, and 0.016 for house services. As regards the joint, it is specified that all permanent joints between aluminum conductors are to be welded, the ends of the wires being butted together and enclosed in an approved metal mold, into which molten aluminum is poured. After the mold is removed the joint is to be cleaned up and any roughness filed off. The joints between the feeders and distributors and at points where the distributors may require to be disconnected, are to be formed by aluminum thimbles bolted together, and the thimbles are to be welded to the ends of the wires as described above.—Lond. *Electrical Engineer,* Sept. 27.

Insulating Varnish.—Several diagrams showing the effect of linseed oil in insulating varnishes. Such varnishes which contain no linseed oil absorb moisture much more slowly, and to a smaller extent, than do those which contain linseed oil. A large moisture absorption necessarily means a low ohmic insulation resistance, but, more important than this, it produces a low dielectric strength. The latter varies according to the dryness of the insulation.—Lond. *Electrical Review,* Sept. 27.

Electrophysics and Magnetism.

Electric Origin of Radiation from Hot Bodies.—J. J. THOMSON.—The idea on which this paper is based is that the radiation from hot bodies is analogous to Roentgen radiation; that is, that it consists of a series of electromagnetic pulses produced by the stopping or starting of charged corpuscles in the hot body. Lorentz formerly followed up this idea of Thomson for the special case of very small frequencies. The object of the present paper is to solve the problem for the general case. The paper is highly mathematical, and the results are somewhat startling. The amount of energy transformed per cu. cm of a metal into radiant energy per second is surprisingly large, but nearly the whole of this is absorbed by the metal and passes into a form other than that of radiant energy. Under special assumptions, the author finds that the flow of radiant energy produced in a cubic cm of silver represents about 8000 horsepower. "Thus, though a cubic cm of silver does not distribute its radiant energy well, it produces as much as a good-sized electric lighting station."—*Phil. Mag.,* August.

Uranium and Radium.—F. SODDY AND T. D. MACKENZIE.—A long account of an experimental research concerning the change from uranium into radium.—*Phil. Mag.,* August.

Rays of Positive Electricity.—J. J. THOMSON.—A reply to Wien's recent criticisms on this subject.—*Phil. Magazine,* August.

Electrochemistry and Batteries.

Electrometallurgy of Copper.—J. W. RICHARDS.—The first part of a discussion of the different methods for applying electric energy in the metallurgy of copper. In the present installment the author deals with electrolytic processes, namely, the electrolytic treatment of copper ores, the electrolytic treatment of copper matte and the electrolytic extraction of copper from solutions with soluble iron anodes.—*Electrochem. and Met. Ind.,* October.

Phosphorus.—G. W. STOSE.—A review of the different electric furnace processes which have been devised for the producing of phosphorus. While formerly phosphorus was made chiefly from rock phosphate and from apatite, wavellite has become a new source of phosphorus in a new electric furnace plant in Pennsylvania.—*Electrochem. and Met. Ind.,* October.

Units, Measurements and Instruments.

Short-Period Electrometer.—E. T. JONES.—For the study of slow high-potential electric oscillations, the author thinks that an electrostatic method would require simpler apparatus than most of the electromagnetic methods, and would have the advantage that no additional self-inductance is introduced into the circuit. He made experiments with the apparatus shown in Fig. 2. A piece of phosphor-bronze strip *S* is soldered at one end to a terminal on an ebonite pillar, *P*, and at the other to a small spiral spring, *L*, attached to a screw. A second ebonite pillar supports the screw, which can be drawn through by a nut, thus allowing the tension of the strip to be varied. The strip rests horizontally against two vertical glass rods, *R*, about 2 cm apart. To the middle of the strip is attached a small mirror, *M*, of very thin silvered glass, rectangular or triangular in form, and 1 or 2 sq. mm in area. In front of the strip, and connected to the terminal by a thin wire, is a thin plate of copper (not shown in the figure), bent so that its edge faces the strip and is less than 1 mm from it. A gap in this plate allows a beam of light to pass to and from the mirror. Behind the strip is another thin plate of copper imbedded in a sheath of ebonite, *K*, and also with its edge facing the strip. The whole is mounted on an ebonite support, and placed in an ebonite vessel provided with a small window and filled with a transparent, insulating oil of suitable viscosity and of fairly high dielectric strength. It is also advantageous that the oil should have a high specific inductive capacity. A small platform, *N*, of ebonite tipped with cork can be raised by a screw until it comes into contact with the lower edge of the mirror. A horizontal adjustment of the platform then allows the mirror to be tilted so that the reflected ray can be made horizontal, or can be given any desired small elevation. The phosphor-bronze strip is thus located between two plates, to one of which it is connected. If the plates are charged to a difference of potential, the strip is repelled by one plate and attracted by the other. The mirror then, since one of its edges is fixed, is deflected through a small angle proportional to the square of the

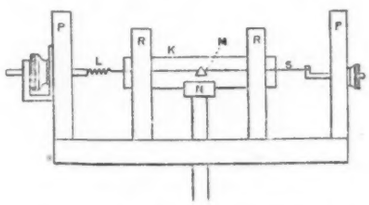


FIG. 2.—DIAGRAM OF ELECTROMETER.

difference of potential of the plates as in the idiostatic use of the quadrant electrometer. A beam of light, proceeding from a small circular aperture illuminated by an arc lamp and condenser, passes through a convex lens and is reflected by the small mirror on to a rotating concave mirror, driven by a motor. It is focused so that an image of the aperture is formed on a plate of ground glass or on a photographic plate. A tuning-fork, carrying a small mirror, is mounted vertically in front of and close to the window of the oil vessel. A part of the beam of light falls upon this mirror, whence it is reflected to the rotating mirror and focused on the plate. When the concave mirror rotates, two horizontal lines are thus traced by the spots on the ground-glass plate. By adjusting the small platform one of these traces can be brought to a short distance from the other. At a certain point of the rotation of the mirror, the tuning-fork is struck by a hammer worked by a lever, after the manner of a pianoforte-key action. The arc lamp is enclosed in a light-tight case and the whole apparatus is set up in a dark room. The author's experiments relate to measurement of periods of oscillations, to measurements of capacity of condensers, to measurements of damping factors, and other applications.—*Phil. Magazine,* August.

Electric Pyrometer.—A description of the Crompton pyrometer in which the thermo-electric couple is used with a suitably calibrated indicator of the moving-coil type, no battery being required. Fig. 3 shows the method of connections for measuring the temperature in a furnace or flue. For temperatures up to 1100 deg. C. the couple is composed of a nickel rod inside a steel tube, the two being welded together at one end and provided with terminals at the other. For lower tempera-

tures, up to 500 deg. C., a constant-copper couple is used. The terminals are marked *N* and *S*, respectively, and the leads are of nickel and steel, so that the materials forming the couple are continuous up to the indicating instrument; very slight insulation is required between them. As the cold junction is at

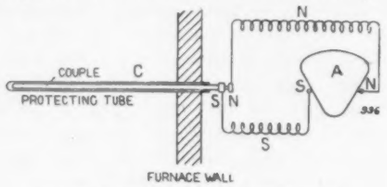


FIG. 3.—PYROMETER CONNECTIONS.

the indicator, and is not always at the same temperature, it is necessary to provide corrections; this has been accomplished by attaching a thermometer to the indicator, and constructing the scale in the manner shown in Fig. 4. The several arcs are calibrated at different temperatures of the indicating instrument ranging from 10 deg. to 30 deg. C., in steps of 5 deg., and the reading should be taken on that arc which corresponds with

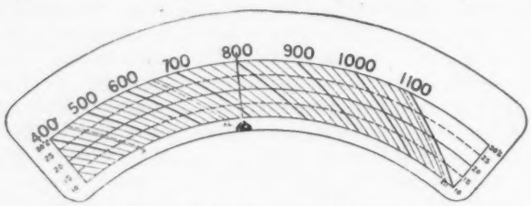


FIG. 4.—SCALE OF PYROMETER.

the thermometer reading. The melting points of sulphur, aluminum and copper are specially marked on the scale for the purpose of checking the readings.—Lond. *Electrical Review*, Sept. 27.

Resistance Coils.—C. V. Drysdale.—The first part of a fully illustrated paper read before the British Association for Advancement of Science, at Leicester. The author gives a survey of resistance coils, showing their evolution up to the present time, and the methods used in accurate measurements of resistance. Results of tests on a number of resistance-alloys are given. The desirable features and temperature compensation of resistance coils are then discussed, and the author describes attempts which he has made at compensation by electro-depositing films of suitable thickness of certain metals on the resistance wires. In conclusion, the methods of standardizing coils and bridges are considered, and a modified form of the Cary Foster bridge, due to the author, is described. In the present installment a great many different designs of resistance coils are described and illustrated in diagrams.—Lond. *Electrician*, Sept. 27.

Telegraphy, Telephony and Signals.

Undamped Oscillations and Wireless Telephony.—S. Eisenstein.—An account of experiments which he has made on the basis of Duddell's well-known arrangement, using the arc for the production of undamped oscillations. In order to increase the oscillation energy, the pressure of the gas in which the arc plays may be raised, and this results also in an increase of the frequency. The nature of the compressed gas which is used around the arc is of no account as long as the gas is of such a nature that the arc does not become a stable one. Methods of obtaining an unstable condition of the arc by means of electromagnetic devices or by air-blast are described. Fig. 5 shows an arrangement for wireless telephony with undamped oscillations. A microphone circuit acts on the machine, which gives the exciting current for the arc. This method has been repeatedly proposed, but always in such a way that an increase of magnetism is produced in the poles of the machine by the microphone circuit. It is, however, evident that the oscillations produced by the speech in the microphone circuit cannot pass with sufficiently large speed through the coils of the poles of the machine. Therefore a lag takes place, so that the weak higher harmonics are completely lost, and only the main oscillations exert the desired effect on the machine. This disadvantage is overcome in the arrangement shown in the illustration, since the microphone circuit is not used for increasing the magnetism of the machine, but, reversely, for demagnetizing it. For this purpose special windings, *a*, are placed on the poles of the machine and they are supplied with current from the microphone circuit. The direc-

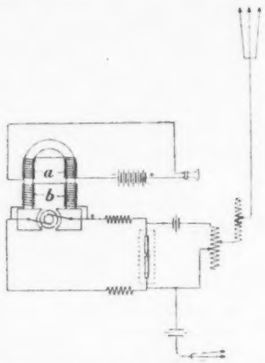


FIG. 5.—DIAGRAM OF CONNECTIONS.

tion of this current, however, is opposite to that in the main windings, *b*. The currents in *a*, therefore, demagnetize the poles of the machine. The demagnetization is much quicker than the increase of magnetization, and for this reason the transmission of speech is better than with the other arrangement.—*Elek. Zeit.*, Aug. 22.

Electric Oscillators.—J. A. Fleming.—While a strict and highly mathematical theory of electric oscillators has formerly been developed, the present author gives in this article an elementary theory for use by workers in electric-wave telegraphy. He elucidates the theory of the oscillator for a few of the simple and most practically important forms of open and closed radiating circuits. The article is to be continued.—Lond. *Electrician*, Sept. 27.

Wireless Telephony.—H. Armagnat.—A concise summary, with diagrams, of the present situation of wireless telephony.—*L'Industrie Elec.*, Sept. 25.

Poulsen Arc.—J. A. Fleming.—His British Physical Society paper in full, with illustrations, giving some observations on the Poulsen arc as a means of obtaining continuous electric oscillations.—*Phil. Mag.*, August.

Cable Ship.—A fully illustrated description of the new cable ship, *Guardian*, built for a British cable company. One novel point in her equipment is that her larger cable tanks are provided with a division wall which divides them into two concentric parts. Great care has been taken in all details to render the vessel suitable for continuous service in tropical latitudes.—Lond. *Elec. Eng'ing*, Sept. 26.

Miscellaneous.

Machine for Working Metal Sheets.—R. Hundhausen.—A fully illustrated description of a machine for treating metal ribbons or strips cut from sheet metal. The ribbon or strip is moved with greatest accuracy and at high speed step by step, and is simultaneously worked into the desired form by cutting, stamping, bending, drawing, etc.—*Elek. Zeit.*, Aug. 22.

BOOK REVIEWS.

"The Electrician" Primers. Edited by W. R. Cooper, M. A., B. Sc. London: "The Electrician" Printing & Publishing Company. Three vols. in one. Illustrated. Price, $5.

The first edition of this set of primers of electricity appeared in 1891, and for this edition has been thoroughly revised by Mr. W. R. Cooper, editor of *The Electrician*, London. The set comprises 25 primers on "Theory," 31 on "Electric Traction, Electric Lighting and Power," and 25 on "Telegraphy, Telephony, Electrolysis and Miscellaneous Applications of Electricity." In plan and scope the work resembles the instruction books of present-day correspondence schools, though the origin of

the primers antedates the latter, and in turn is antedated by the popular primers issued during the Philadelphia electrical exhibition of 1884.

The primers are particularly adapted for self-study by practical men who cannot take up a systematic and broad course of study in electrical science and engineering. Each primer is devoted to a specific subject, the treatment of which is complete, so far as possible, in itself, and without reference to other primers. The student can thus select for first reading the topics which appeal most directly to him, leaving the others for later consideration or for possible future reference. The treatment is entirely practical and largely descriptive. A useful feature is a list at the end of each primer referring to books which may be consulted for information in fuller detail.

Handbook on Engineering. By Henry C. Tully. Sixth edition. St. Louis: Henry C. Tully & Co. 1072 pages; 473 illustrations and frontispiece portrait of author. Price, $3.50.

The author in his preface says that an experience of 25 years with all kinds of engines and boilers, pumps and "all other kinds of machinery" enables him fully to understand the kind of information most needed by men having charge of steam engines of every description, and that he has excluded from the book everything not strictly connected with steam engineering. The long sub-title, however, includes dynamos, motors and electric elevators, and we find that no less than 14 of the 31 chapters deal with electrical subjects. The author is at times rather unfortunate in his choice of material, and its arrangement is rarely logical while there is little distinction between the more and less important, and old and wellnigh obsolete apparatus is apt to be described to the exclusion of the more modern. The chapters on electrical matters will doubtless suffice for the practical steam engineer who has the care of electrical apparatus thrust upon him, and who desires only a smattering of electrical knowledge. While the book contains much that is good, its sins of omission and commission are many, and this is hardly excusable in a sixth edition.

Die Telegraphie Ohne Draht. By Prof. Augusto Righi and Prof. Bernard Dessau. Braunschweig: Friedr. Vieweg & Sohn. 665 pages, 312 illustrations. Price, 15 marks.

This volume is the second and revised edition of the excellent treatise on wireless telegraphy by Prof. Righi, of the University of Bologna, and Prof. Dessau, of the University of Perugia. The matter in the book has been thoroughly revised to date of publication, and a number of sections added to take account of the latest developments in wireless telegraphy. A new section is that on the theory of electrons and the section on electric waves has been enlarged in order to take account of the latest investigations on this subject, having particular bearing on wireless propagation. Magnetic and electrolytic detectors form the subject of still another new section.

About half the book is devoted to descriptions of systems and of apparatus, in which all the newer apparatus is fully covered. An appendix is devoted to the Poulsen system, written after the main portion of the book had gone to press. It may be added that the authors in their preface speak highly of the possibilities of this system. Another appendix contains German rules that have been laid down for the control of wireless communication, and the full text of the regulations laid down at the recent International Wireless Telegraph Congress.

A valuable feature of the book is a list at the end of each chapter of references to all of the authorities quoted or referred to in any manner, the aggregate of these additions forming a valuable contribution to the bibliography of wireless telegraphy. References to the principal patents are given by number and date.

All interested in wireless telegraphy will find this work not only of value and interest as a treatise on the subject, but a most useful book of reference. It is, in fact, the most important treatise on wireless telegraphy which has thus far appeared in print, both from its authoritative character and the thoroughness in which every phase of the subject is considered.

Practical Magnetism and Electricity. A First Year's Course Specially Adapted to the Wants of Technical Students. By P. E. Shaw, B. A., D. Sc. London: "The Electrician" Printing & Publishing Company. 64 pages (interleaved), 51 illustrations. Price, $1.

The author in his preface states that this little book is designed for the use of a large and growing class of technical students who have not even a primitive mathematical training, and who cannot, or will not, acquire it as a foundation for physical science; this class is later referred to as consisting of skilled or unskilled artisans who require some knowledge of electricity in their daily work.

Aside from brief explanations of elementary theory, the contents of the book consists of brief descriptions of, and simple experiments with, galvanometers, resistance boxes, potentiometers, ammeters, voltmeters, telephones and telegraphs. Various other subjects are briefly considered, such as primary cells, the wireless telegraph, the electric motor, and the candle-power and efficiency of the incandescent lamp. The range is a large one to be covered in 64 pages, but the book should be of service to those who desire to obtain a speaking acquaintance with electrical principles with the least possible labor, or may serve as a reference book for manual training school students. The sheets are interleaved with blank paper.

"The Electrician" Electrical Trades Directory, 1907. London: "The Electrician" Printing & Publishing Company. Price, $6.

With the present issue, the well-known "Blue Book" completes a quarter century of useful existence, during which it has grown from a slim volume to a bulky tome of more than 2000 pages. The present edition returns to a former practice by including in one volume the directory and biographical sections; the wisdom of this recombination one may well doubt in handling the bulky results. To recapitulate adequately the features of this valuable combination of reference book and directory would take columns of space, and would be unnecessary in the case of such a well-known publication. Among new matter are notes on progress during 1906 in electric traction, electric power, and on the application of electric motors to industrial work; submarine and overland telegraphy, and of wireless telegraphic development, both at home and abroad. In addition are noted the salient features of post office, national and municipal telephone progress in the United Kingdom in 1906, the development of the steam turbine, the progress made in electric lamp improvements. A summary is given of Parliamentary work in the past session so far as legislation has affected the electrical industry. The law of electric lighting, electric power, electric traction, telegraphs and telephones is covered by a digest prepared by Mr. A. C. Curtis-Hayward, solicitor, and the principal legal decisions of the High Courts in 1906 affecting the electrical industry are also digested. The subject of patent law and expiring patents, of rules for the installation of electric light, power and traction plants in Great Britain, the underwriters' rules of all the leading companies, as well as those which govern electrical installations in the United States, Germany, France, Switzerland and other Continental countries, and also in the British colonies, are included in this volume.

Essais des Machines a Courant Continu et Alternatif. By P. Bourguignon. Paris: Ch. Beranger. 298 pages. Price, 15 francs.

The author of this volume has presented a very practical and fully illustrated treatise of elementary tests on direct and alternating-current machines. The scope of the work is indicated by the following brief analysis of the chapters:

I, Introduction; II, Rheostats; III, Characteristics of Generators and Motors; IV, Measurement of field and armature winding resistances, and of temperature-elevations; V, Measurement of efficiency; VI, Different types of mechanical brakes; VII, Opposition methods; VIII, Tests of series motors; IX, Analysis of losses in machines; X, Measurement of the mag-

netic leakage coefficient; XI, Determination of wave shape of alternating currents; XII, Tests of alternators; XIII, Tests of transformers; XIV, Tests of synchronous motors and commutator motors; XV, Tests of synchronous motors; XVI, Tests of single-phase commutator motors; XVII, Determination of magnetic distribution along pole pieces.

At the end of the book is a collection of the standardization rules of the American Institute of Electrical Engineers, of the German Verband Deutscher Elektrotechniker, of the Association Alsacienne des Proprietaires d'Appareils à Vapeur and of the Syndecat Professionel des Industries Electriques in Paris. The provisions of these various sets of rules are repectively compared in a brief final chapter.

The treatment is clear and employs graphic methods to a considerable extent. The book will be of value to students of electrical testing of machinery in all parts of the world. An index of subject-matters is much needed and it is hoped that a subsequent edition may furnish one.

Modern Lightning Conductors. By Killingworth Hedges. London: Crosby, Lockwood & Son. 119 pages, 74 illustrations. Price, 6 shillings 6 pence.

The author of this useful book is the honorary secretary of the British Lightning Research Committee, and in that capacity has since 1901 personally or through several hundred enrolled observers investigated numerous cases of lightning stroke with a view to gathering data bearing upon the protection of life and property from this danger. The book gives under a number of heads digests of the more instructive of the reports received, in many cases accompanied by illustrations, which matter is supplemented with practical information on the subject of lightning protection, together with notes on a wide range of subjects having more or less connection with lightning. In fact, the book lacks logical arrangement, and has rather the character of a collection of notes, many of a random nature, than that of a systematic treatise on the subject indicated by the title. It supplies, however, a much needed contribution to a subject represented by a very meagre literature.

The book opens with a reprint of Sir Oliver Lodge's introduction to the Lightning Research Committee's Report of 1905, which is short and perfunctory. Chapter I gives an account of the formation of the committee. The following chapter has the head, "Characteristics of a Flash of Lightning," and consists principally of abstracts from the committee's report and Lodge's "Lightning Conductors." Chapters III and IV are the most important in the book, consisting of a reprint of the committee's suggestions and rules for lightning protection, with an illustrated account of methods of protection and testing. Chapter V, entitled "Considerations as to Cost and Specifications," includes a specification by the author for various kinds of buildings. Chapter VI consists of notes on American and Continental practice, and the two following chapters contain selections from observers' reports. The two final chapters consist of miscellaneous notes. A method patented by the author for lightning protection figures largely in the text and in an advertising section bound with the book.

Brakes for Tramway Cars. By Henry M. Sayers. London: "The Electrician" Printing & Publishing Company. 76 pages; illustrated. Price, $1.50.

This little pamphlet is based upon a series of articles contributed by the author to *The Electrician*, of London. The opening chapter treats of general considerations; the three following chapters are devoted to wheel brakes; chapter 5 has for subject track brakes, mechanical and magnetic; chapter 6 treats of the adjustment and maintenance of brakes, and the following chapter gives a reprint of a long report on an accident caused by a defective brake, while in the final chapter are formulas and constants for the calculation and tests of brakes and of acceleration and retardation. The descriptions of brakes are confined to somewhat summary accounts of the Raworth's regenerative brake, the General Electric magnetic track brake, and the Westinghouse combined track and wheel brake.

Electricity in Mining. By Sydney F. Walker. New York: D. Van Nostrand Company. 385 pages, 163 illustrations. Price, $5.00.

The author is well known as an authority on application of electricity to mining work, of which he has been a doughty advocate for a score of years or more, through the technical press and in papers before professional societies. He is therefore particularly fitted to be the author of a book on the subject. While the work has little of the character of a systematic treatise, it enters fully into the practical side of the subject, although the different phases of it are treated without much connection with each other. Considerable space is given to the description of boilers, prime movers and the accessories, which have no further connection with the subject than that they are necessary in the generation of electric power, and similarly many of the descriptions of electrical apparatus, such as the mechanism of various types of arc lamps, appear out of place. The book opens with the inevitable chapter on electrical theory. Its real subject is taken up in the second chapter, which deals with electric mining signals in detail, blasting by electricity, and electrical firing apparatus. Apparently in order to be considered up to date, the author has added a section on "Wireless Telegraphy for Mines." The following section is on electric lighting for mines, very little of which, however, relates specifically to electric mining work except the final section on portable electric lamps. Chapters 4 and 5 on the generation of electricity and distribution of power by electricity deal largely in descriptions of apparatus that would appear to have only an academic interest to the average person connected with mining. Here and there, in these chapters, however, there are pages in which specific applications to mining work are described. Chapter 6 is on application of electricity to driving machines, etc., in mines, and this is directly to the point, relating specifically to the use of electric motors at the shaft-head and in the mines for cutting, hauling and ventilation. The final chapter is on faults in electric apparatus, their detection and correction.

Owing to the rather haphazard arrangement of the book, and the large amount of extraneous matter, the work is not so well fitted for consecutive reading as it is for reference; but in the latter respect, it will be found useful by everyone interested in mining operations.

Prüfung Elektrischer Maschinen und Transformatoren. By Friedrich Weickert. Hannover: Dr. Max Jänecke. 119 pages, 64 illustrations. Price, 1.80 marks.

This little book is No. 50 in the Jänecke "Bibliothek der Gesamten Technik," which at present includes almost 60 titles. It is intended more particularly as a handbook for working electricians in the testing of electrical generators, motors and transformers. The first section gives brief descriptions of various forms of measuring apparatus. The second section treats the methods of measurements, and the third section—which occupies more than half the book—gives instructions for the application of the methods to direct-current machines, alternators, synchronous motors, and single, two and three-phase motors and transformers. The book should be useful to the class for which it is intended, and is not without interest to electrical engineers in general.

Die Krankheiten Elektrischer Maschinen. By Ernst Schulz. Hannover: Dr. Max J. Jänecke. 88 pages, 42 illustrations. Price, 1.40 marks.

The English translation of the above title—"The Diseases of Electrical Machinery"—indicates clearly the character of the contents. The present is a second and revised edition of the book. There are four main sections, treating respectively the subjects of direct-current machinery, single and polyphase generators, single and polyphase motors, and single and polyphase transformers. A fifth section considers the subject of efficiency. All the various troubles that may arise in the operation of these types of machinery are considered in turn, and directions given as to how they may be remedied.

Electric Blasting, Apparatus and Explosives, with Special Reference to Colliery Practice. New York: D. Van Nostrand Company. 166 pages, 84 illustrations. Price, $3.50.

While written with reference more especially to coal mining, this work will be found useful to all having to do with electric blasting. The subject is treated under the heads of electric fuses and detonators, exploders, wires and cables, testing, explosives and explosive risks, practical applications, laws and regulations relating to the storage and use of explosives. The sections of the book of the greatest value from the practical standpoint are the two latter. That on practical applications gives instructions in full detail for drilling, adjusting the charge to the work in hand, tamping, connecting up, precautions to observe, etc. The British laws and regulations relating to the use and storage of explosives are valuable both for reference and information of direct practical value.

Explanations of Switch and Signal Circuits. By John T. Doran. New York: Doran & Kasner. 140 pages; illustrated. Price, $1.50.

Evidently intended for the guidance of railway men needing practical information relating to the connections and maintenance of railway track signals, this little book merits favorable consideration from this class. Numerous diagrams of circuits are given with accompanying descriptions in many cases, and a number of half-tone plates illustrate apparatus in place. The text also includes a short section on storage batteries and a reprint of such rules of the National Electrical Code as apply more particularly to the conditions of signal wiring in railroad buildings.

Electrical Equipment of the Laurentide Pulp & Paper Company.

By Norman G. Meade.

The mills of the Laurentide Pulp & Paper Company are located at Grand Mere, Province of Quebec, Canada, on the banks of the St. Maurice River, which supplies water power for the generating station and the departments that are operated by hydraulic power. The credit for the successful design and installation of this plant is due to Mr. George F. Hardy, mill architect and hydraulic engineer, of New York City, who was one of the first engineers to advocate electric drive for pulp and paper machinery.

The generating equipment consists of two 300-kw, three-phase, 25-cycle, 440-volt revolving-field generators direct-coupled to

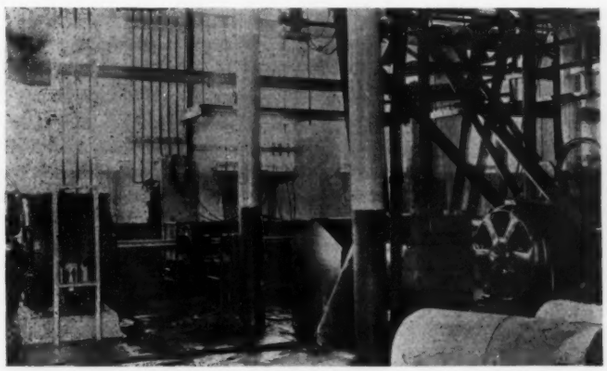


FIG. 1.—200-HP AND 75-HP MOTORS DRIVING PAPER MACHINE.

40-in. water-wheels rated at 550 horse-power each. Lombard water-wheel governors are used, and direct current for excitation is furnished by a 37½-kw, 125-volt, direct-current generator.

The motor equipment is supplied with energy from a three-phase, 25-cycle, 440-volt system of distribution and consists of the following applications: One 50-hp motor driving six wet machines for ground wood pulp, with a combined capacity of from 130 to 150 tons per day, and 20 Decker screens; one 40-hp motor driving 14 screens; one 200-hp motor driving the variable speed end, and one 50-hp motor driving the wet end of a Fourdrinier paper machine making newspaper 114½ ins. wide at the rate of 374 ft. per minute. This machine is

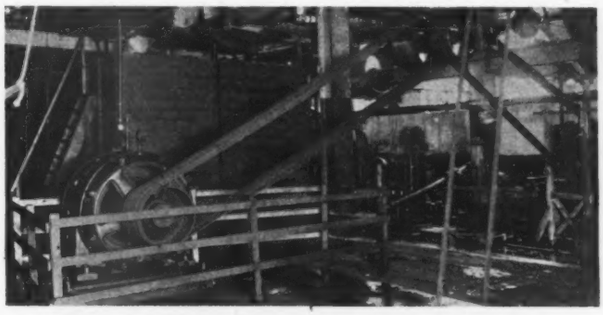


FIG. 2.—100-HP INDUCTION MOTOR DRIVING TRIPLEX PUMPS.

equipped with 30 dryers; one 200-hp motor driving the variable-speed end, and one 75-hp motor driving the wet end of a Fourdrinier paper machine making newspaper 92 ins. in width at the rate of 503 ft. per minute. This machine is equipped with 29 dryers; one 40-hp motor driving a beater, used for beating waste paper from the paper machines. By means of

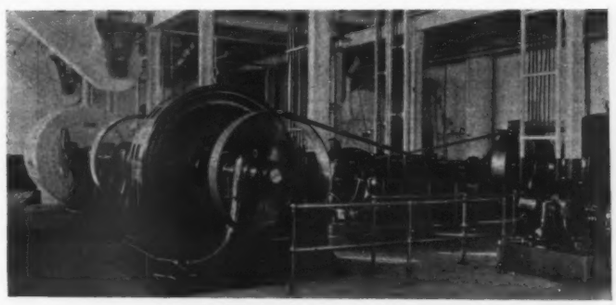


FIG. 3.—INTERIOR OF POWER HOUSE.

a Morse chain-drive, slippage with belts is avoided, and the vertical adjustment of the beater roll is easily accomplished. One 40-hp motor operating a block chain for conveying wood blocks to the wood room. This chain runs at an angle to a height of 65 ft. and extends 350 ft. horizontally. One 100-hp motor driving five triplex pumps for general water supply.

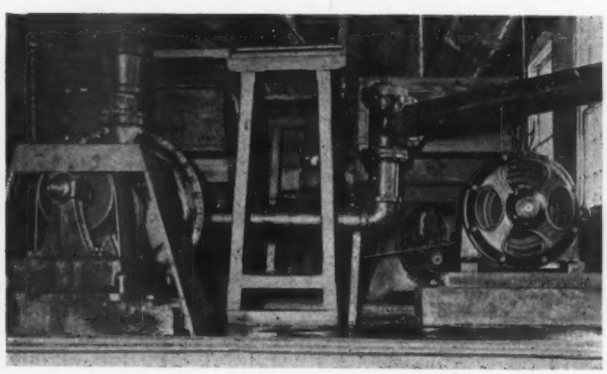


FIG. 4.—40-HP INDUCTION MOTOR OPERATING SCREEN.

One 30-hp motor operating an incline elevator and small repair shop; one 20-hp motor operating a small elevator, and one 15-hp motor operating an elevator in the acid tower.

The motors are all of the polyphase induction type and were supplied, with the rest of the electrical equipment, by the Westinghouse Electric & Manufacturing Company.

Vertical Turbo-Generators.

The accompanying illustrations indicate some interesting solutions of the many difficult problems encountered in the design of high-speed turbo-generators. A four-pole smooth-core rotor field structure in course of construction is shown in Fig. 1. The main body of the magnetic material is built up of steel discs containing uniformly spaced dovetails. The pole faces are built up into place by inserting bundles of steel "teeth" which fit snugly into the dovetailed slots, the coils are then

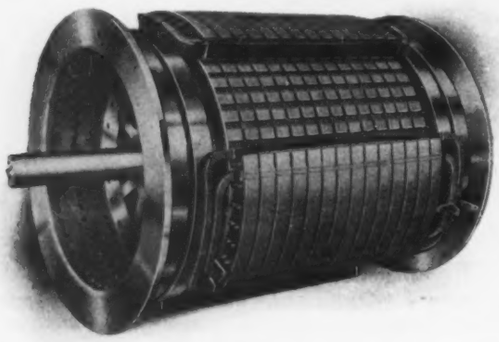


FIG. 1.—FOUR-POLE SMOOTH-CORE ROTOR IN COURSE OF CONSTRUCTION.

laid on the remaining surface, and additional teeth, with recesses for containing the coils, are slipped into place. When the "dental work" is completed, the form-wound field coils are contained in slots that are almost closed, and from which they can not possibly be thrown by centrifugal force. The end portions of the field coils are held in position against the outward thrust by means of heavy steel bands, which are bolted to the armature spider. The rigid method of supporting the field coils insures

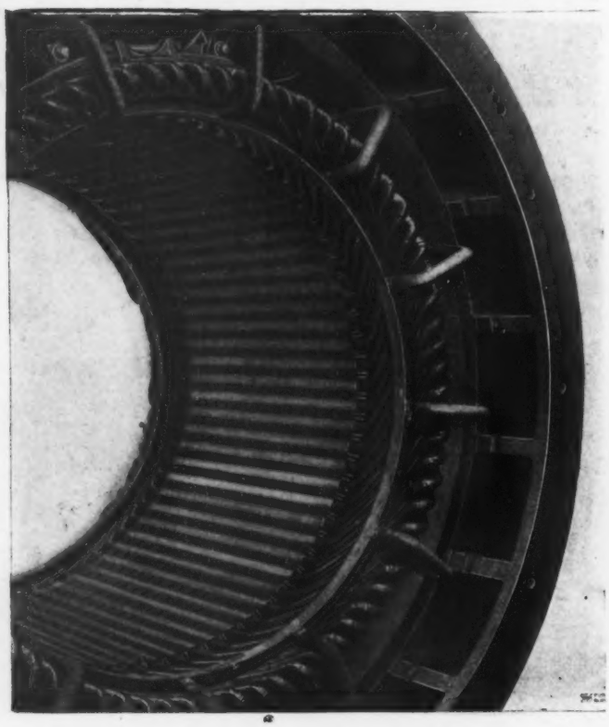


FIG. 3.—STATIONARY ARMATURE WINDING.

the maintenance of perfect balance and gives wonderful mechanical strength to the whole revolving structure.

Fig. 3 shows the solid support used for the end portions of the stationary armature coils, which effectually prevents the possibility of injury by motion which otherwise would be caused in the end portions by the magnetic strains imposed by short circuits.

The rotor core is so designed that it acts as a powerful impeller, which forces a large volume of air definitely into the parts of the generator structure requiring ventilation. The air is taken into the generator usually through a single opening and is discharged after it has circulated through the cores and windings. The outside casing of the stator is a closed casting which serves to deaden the sounds which may be occasioned by movements of air in the machine, and at the same time it does not prevent proper flow of air to all parts which it should reach. The air-impelling force of the rotor is so definite that the air supply can be drawn through a pipe from some outside source,

FIG. 2.—SMOOTH-CORE ROTOR FOR 9000-KW TURBO-GENERATOR.

which is generally desirable in order to secure cool air. It is stated that the generators provided with the ventilating devices described above operate practically without noise.

The method of constructing turbo-generators here outlined is the one employed by the General Electric Company with its large machines that are driven by vertical Curtis turbines. The illustrations show parts of one of four 9000-kw turbo-generator units installed in the Fisk Street station of the Commonwealth Electric Company of Chicago. It is interesting in this connection to note that at a load of 10,186 kilowatts, a steam gauge pressure of 176 lbs. per sq. in., superheat of 147 degs. F., and a vacuum of 29.47 ins. mercury, the steam consumption was 12.9 lbs. per kw-hour.

Motor-Driven Valves.

One of the great inconveniences of a large water-works system resides in the fact that the valves and gates cover such a large area that control of them is very difficult. This inconvenience is very simply overcome by operating the valves by means of electric motors, each valve being equipped with a small motor. Not only does this system permit control from a distance, but the time consumed in opening and closing the

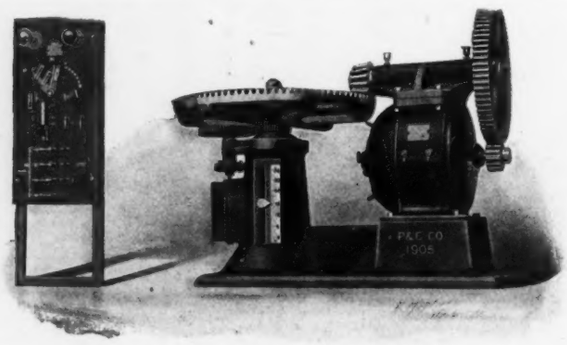


FIG. 1.—FLOOR STAND AND CONTROLLING PANEL.

valve is reduced to a minimum as is also the labor expended. In the case of valves of any considerable size the latter is an important item.

Each valve equipment consists of valve and gearing, a motor and an automatic limit switch. The controlling mechanism consists of a double-throw switch and a starter. A floor stand and

controlling panel are shown in Fig. 1, and a complete equipment in Fig. 2.

The operation of the valve is as follows: The limit switch is so constructed that when the valve is at either end of its motion the motor can be operated only in the proper direction. If the valve be open and it is desired to close it, the double-throw switch on the panel is thrown over and the motor is thus started. When the valve closes, the limit switch automatically opens the circuit and stops the motor. The motor can then be started only in the opposite direction. This is done by throwing over the double-throw switch and re-starting the

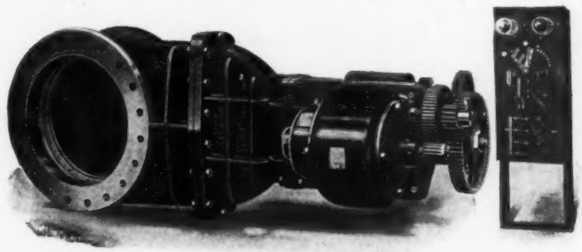


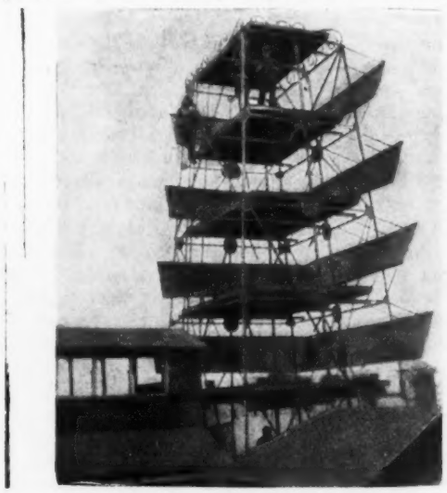
FIG. 2.—COMPLETE MOTOR-DRIVEN VALVE EQUIPMENT.

motor. When the valve opens fully the limit switch again opens the circuit. Thus, it will be seen that the operation is very simple and accidents from misuse impossible.

The motors, which are built by the Crocker-Wheeler Company of Ampere, N. J., are of very compact construction, have a large torque, and are capable of withstanding heavy over-loads. For this reason very small space is necessary for the motor, in comparison with the force required. A large number of these valve equipments have been recently installed in the Cincinnati Water Works, and have given satisfaction.

Sectional Cooling Tower and Spray Preventer.

The principal difficulties that have been experienced in the operation of cooling towers of the open, natural draft type have been the limited exposure of the water to the air currents, due to the spray in the outer portion of the tower blanketing the inner portions of the tower, and the loss of water in spray



COOLING TOWER AND SPRAY PREVENTER.

blown by the wind beyond the limits of the tower. These have both been eliminated, it is claimed, in the new design of tower construction recently perfected by B. Franklin Hart, Jr., & Company, New York, which is here illustrated. The feature of the new tower is the use of a new form of sectional cooling tray with serrated edges causing the water to fall from stage to stage in finely divided streams, and yet permitting the general distribution of air currents throughout all portions of the tower between the sectional trays. The sectional trays as installed are long, shallow troughs a few inches in width which are built in any length required by the capacity of the tower and are located in the tower in stages with small spaces between edges. While ordinarily built of galvanized iron, they may be built of copper, wood or cast-iron where the liquid to be cooled might attack the sheet metal, it only being necessary to cut grooves in both edges at frequent intervals through which the water may run over the edges. The trays are of light construction, and are supported by structural iron framing, the attaching bolts at either ends of the trays serving as the spacers between edges. This permits them to be easily removed at any time desired for replacement or for change in arrangement. The entire construction is well adapted to installation in old towers which have been found of insufficient capacity or where tower construction is not permissible and it is necessary to install the system in ill-adapted spaces. Owing to the spaces between trays, the efficiency of this type of construction in operation is claimed to be greater than that of the other forms.

The spray preventer construction involves the use of galvanized-iron baffle plates or enclosures, which are hung at each stage and on such sides as to catch the spray carried outside by prevailing winds. The baffles are hung some distance out from the tower so as not to interfere with the wind currents of ordinary intensity, and are inclined inward toward the bottom which is flanged into a gutter to collect the water and deliver it to the tower again. The tower is intended for cooling water and liquids for any purpose and is effective without the use of fans or moving machinery.

Electrically-Driven Milling Machine.

The illustration herewith shows a recent application of motor drive to a milling machine. A 2-hp, 3-to-1 variable-speed motor is mounted on a plate on the rear side, and geared direct to the spindle. The motor is thus located in the most desirable position as regards space, protection from dirt, and efficiency of transmission. The rheostat and switch are mounted on the front plate in convenient reach of the operator. The gearing

ELECTRICALLY-DRIVEN MILLING MACHINE.

is totally enclosed. The machine, which is simple and substantial, is intended for general plain milling. The table has a screw feed, with automatic trip and quick movement by a large hand wheel. Micrometer vertical adjustment of the knee is provided, and the telescope arm carries a hardened and ground outboard bearing for the arbor. The weight of the machine is 1700 lbs. The maker is the Garvin Machine Company, of New York.

Industrial and Commercial News

Commercial Intelligence.

THE WEEK IN TRADE.—Reports of the mercantile agencies indicate that a larger volume of business was transacted during the week than in the same period last year, although the conditions in 1906 were more favorable and there is now the handicap of almost prohibitive rates for commercial paper. Many contemplated undertakings await more normal financial conditions, but general business throughout the country is making fairly good progress. Seasonable merchandise moved briskly but reports of collections were irregular. In agricultural districts the marketing of the crops at high prices makes the payments satisfactory, but at many Eastern centres there is complaint of delayed settlements. Several strikes are still retarding progress and some machinery is idle at woolen mills, but most industrial plants are well occupied and are assured of continued activity, up to the end of the year, at least. Railway earnings in September were 11.1 per cent larger than in 1906, and foreign commerce at the port of New York during the week showed a gain of $588,181 in exports, and a loss of $2,114,735 in imports. Building materials as a whole are quieter. Iron is quiet and the volume of finished goods ordered is smaller than some time ago, although rails and structural material are slightly more active. Future trade in the latter, however, is not up to expectations, for which the tightness of the money market is largely responsible. The demand for steel rails is somewhat improved, but financial difficulties and the failure of the manufacturing and railroad interests to agree on specifications retard the placing of much new business. Copper was weaker, the pressure to sell being very marked. Quotations for lake brands for future delivery are now on the basis of 14 to 14¼ cents, while for electrolytic as low as 13½ to 13⅝ cents has been named. Lake closed at 14 cents; electrolytic 13⅝ cents; casting 13½ cents. *Bradstreet's* reports 192 business failures in the United States during the week, against 177 in the previous week and 192 in the corresponding period of 1906.

THE B. F. STURTEVANT COMPANY, Hyde Park, Mass., reports the following sales of electric generating sets, noted by F. R. Chinnock of the electrical department from its New York office, Engineering Building, 114 Liberty Street: Benj. Hitchings, Flatbush, Brooklyn, N. Y., one 9 x 8 vertical engine, 22½-kw generator. David Rodgers Company, Paterson, N. J., one 13 x 12 horizontal engine, 50-kw generator. International Paper Company, New York City, one 5 x 5 vertical engine, 6-kw generator. Chas. E. Ring & Company, Brooklyn, N. Y., one 9 x 9 vertical engine, 30-kw generator. Peter Hauck Brewing Company, Harrison, N. J., one 13 x 13 horizontal engine, 50-kw generator. Chas. Hakemeyer Company, Paterson, N. J., one 17½-kw generator. Bedford Reformatory for Women, Bedford, N. Y., one 13 x 12 horizontal engine, 50-kw generator. Department of Docks and Ferries, New York City, ferryboat *New York,* two 9 x 8 vertical engines, 30-kw generators; ferryboat *Richmond,* two 9 x 8 vertical engines, 30-kw generators; ferryboat *Castleton,* two 9 x 8 vertical engines, 30-kw generators; ferryboat *Queens,* two 9 x 8 vertical engines, 30-kw generators; ferryboat *Middletown,* two 9 x 8 vertical engines, 30-kw generators; ferryboat *Gowanus,* two 9 x 8 vertical engines, 30-kw generators; ferryboat *Bay Ridge,* two 9 x 8 vertical engines, 30-kw generators. J. G. White & Company, New York City, two 3½ x 3 vertical engines, 3-kw generators. American Sapphire Company, Colorado, one 7 x 7 vertical engine, 15-kw generator. Chrome Steel Company, Chrome, N. J., one 3½ x 3 vertical engine, 3-kw generator. American Can Company, Lubec, Maine, one 13 x 12 horizontal engine, 50-kw generator; one 10-hp motor; one 15-hp motor. Wm. Sheehan & Company, New York City, one 11 x 10 horizontal engine. H. Wales Lines Company, Meriden, Conn., one 11 x 10 horizontal engine, 30-kw generator; one 7 x 7 vertical engine, 15-kw generator. Eagle Brewing Company, Newark, N. J., one 11 x 10 horizontal engine, 40-kw generator. James Shewan & Sons, New York City, four 7 x 7 vertical engines, 25-kw generators. Vulcan Detinning Company, Sewaren, N. J., one 7 x 7 vertical engine. Tintern Manor Water Company, Redbank, N. J., one 4½ x 4½ vertical engine, 5-kw generator; one 6 x 5 vertical engine, 7-kw generator. Hudson Companies, York Street operations, Jersey City, N. J., three 10-18 x 10 vertical cross-compound engines with 100-kw generators; one 8-14 x 8 vertical engine, 50-kw generator; two 8-14 x 8 vertical engines, 50-kw generators; two 12 x 10 vertical engines, 50-kw generators.

WESTINGHOUSE FACTORIES.—A prominent official of the Westinghouse Electric is reported from Boston as follows: "Both the General Electric and Westinghouse Electric Companies have been conducting their manufacturing operations under such high pressure during the past five or six years that they have fallen far short of the best manufacturing results obtainable under normal conditions. Until within a few months the orders of both companies had greatly exceeded their respective manufacturing facilities, and all operations were necessarily conducted under high tension and with much crowding. The Westinghouse Company is taking advantage of the present general condition, while maintaining its output at the rate of $40,000,000 per year, to make rearrangements and changes which, when completed, will greatly increase the total capacity of its several works. In carrying out these changes many employees who have been engaged in night work can be dispensed with, as well as a large number who have been engaged in building operations, which are now practically completed."

NEW METHOD OF INSULATING WIRE.—An invention for insulating wire for electrical purposes with an enamel finish instead of with silk or cotton, has been sold by Charles H. Shaffer, of Muskegon, Mich., to W. H. Reynolds, Harry Diefendorf and Abraham Weymouth, of Chicago. Mr. Shaffer retains the royalty of 10 per cent and the right to manufacture. The machine consists of a slender perpendicular oven, eight f·· tall, through which the wire passes to be heated for the process, and of a chemical bath beneath, in which the wire is dipped. The solution is a secret one. Wire as fine as a No. 40 has been thus prepared in the tests and it is asserted works successfully at double the voltage as in the old method. The buyers say that they are now negotiating to sell their acquisition to a large Chicago wire firm.

TURBO ALTERNATORS FOR YOUNGSTOWN.—The Youngstown Sheet & Tube Company, of Youngstown, Ohio, has just completed the purchase of two 1500-kw Allis-Chalmers steam turbine units for addition to the present plant at Youngstown. Mr. Julian Kennedy, of Pittsburg, was the consulting engineer. Both units are for 25-cycle, 3-phase currents at 6600 volts, one to operate condensing and the other non-condensing with steam pressure of 150 lbs. per sq. in. The exhaust from the non-condensing turbine will be utilized for heating boiler feed water in an open-type heater.

CATALOGUES AND PRICES.—Mr. Miller Reese Hutchison, exporting engineer, 1 Madison Avenue, New York City, representing in the United States several foreign importing concerns, requests six catalogues and six export price lists of the following: mining machinery and supplies; steam plant machinery and supplies; pipe fittings and pipes; electrical machinery and supplies; sawmill machinery and supplies; industrial railway machinery and supplies; gasoline, gas and oil engines; building materials; machine and hand tools.

NAVY BIDS.—The Bureau of Supplies and Accounts, Navy Department, Washington, will open bids Oct. 29 for electrical supplies, as follows: 22 distribution cabinets and panels for the Charleston, S. C., Navy Yard (schedule No. 413); electrical supplies and 40,000 glass tube fuses for the Mare Island, Cal., Navy Yard (schedule No. 375); 1 motor generator outfit for the Norfolk, Va., Navy Yard (schedule No. 378), and 1 motor drive outfit for the Charleston, S. C., Navy Yard (schedule No. 381).

NEW JERSEY ELECTROCUTION.—The Board of State Prison Inspectors of New Jersey has just awarded the contract for the electrical apparatus for the new electrocution building to the Adams Electric Company, of Trenton, for $1,640. The

bid calls for the work to be completed in six weeks. From the appropriation of $10,000 which the Legislature appropriated for the electrocution building the board has only $362 left. The matter of the expense of the electrocutions for which the Legislature made no appropriation has been taken up by James Mitchell, of Millville, president of the board of inspectors, with Attorney-General McCarter, who was asked by Mitchell if the surplus left from the general state prison appropriation, which will amount to about $7,000 this year, could be used to defray the expenses of electrocuting condemned murderers. The attorney-general recommended that a special act or appropriation be asked for of $2,500. It is stated that the average cost per electrocution in other states is $200.

Financial Intelligence.

THE WEEK IN WALL STREET.—The stock market was nervously irregular and showed decided weakness at times, with declines throughout the list, due to high money rates, threatened gold export, and heavy foreign liquidation. Other unfavorable features were the failure of the expected Northern Pacific extra dividend to materialize, and disquieting revelations regarding traction finance at New York. Both industrial and railroad stocks suffered equally; the copper shares being also depressed on renewed concessions in the metal. There was further pressure on the United States Steel shares, coupled with reiterated statements that the company's orders were diminishing. Southern Railway was again the object of selling, and made another low record for the year. There was little business transacted in electric stocks and in some cases the declines were heavy. Westinghouse led the declines with a net loss of 16½ points, the closing quotation being 110. General Electric followed with a net decline of 10 points, closing at 114½ after touching 113⅛. On the curb market, prices reached new low levels for the year in some issues under renewed liquidation. The mining group suffered most, but various high-priced shares stood the pressure of the selling very well. Following are the closing quotations of October 15:

NEW YORK.

	Oct. 8	Oct. 15		Oct. 8	Oct. 15
Allis-Chalmers Co	7	6⅛	General Electric	122	111¾
Allis-Chalmers Co. pfd.	19½	16	Hudson River Tel.	—	—
Am. Dist. Tel.	—	20	Interborough Met. com.	9¼	8
American Locomotive	50½	45½	Interborough Met. pfd.	24½	22⅝
Amer. Locomotive pfd.	99¼	92	Mackay Cos.	59¼	57½
American Tel. & Cable	75	75	Mackays Cos. pfd.	58½	56
American Tel. & Tel.	104	100	Marconi Tel.	—	—
Brooklyn Rapid Transit.	45⅝	41	Metropolitan St. Ry.	35	35
Electric Boat	—	—	N. Y. & N. J. Tel.	99	—
Electric Boat pfd.	—	—	Western Union Tel.	72	69
Electric Vehicle	—	—	Westinghouse com	115	110
Electric Vehicle pfd.	—	—	Westinghouse pfd	165*	—

BOSTON.

	Oct. 8	Oct. 15		Oct. 8	Oct. 15
American Tel. & Tel.	105	102	Mass. Elec. Ry. pfd.	47½	—
Cumberland Telephone.	—	98½	Mexican Telephone	—	1¾
Edison Elec. Illum.	—	198	New England Telep.	—	—
General Electric	125	112¼	Western Tel. & Tel.	—	4½
Mass. Elec. Ry.	—	—	West. Tel. & Tel. pfd.	—	—

PHILADELPHIA.

	Oct. 8	Oct. 15		Oct. 8	Oct. 15
American Railways	46½	46½	Phila. Electric	7½	7⅛
Elec. Co. of America	8⅞	8½	Phila. Rapid Transit	19½	17½
Elec. Storage Battery	42	39	Phila. Traction	87	86¾
Elec. Stor. Battery pfd.	—	—			

CHICAGO.

	Oct. 8	Oct. 15		Oct. 8	Oct. 15
Chicago City Ry.	150	140	National Carbon	—	60
Chicago Edison	—	85	National Carbon pfd.	—	117
Chicago Subway	—	16¾	Union Traction	—	—
Chicago Tel. Co.	—	105	Union Traction pfd.	—	—
Metropolitan Elec. com.	19	20*			

*Asked.

WESTERN UNION REPORT.—The annual report of the Western Union Telegraph Company, which was made public last week, shows the largest increase in gross earnings in the past eight years. The actual gain in gross was $2,180,752, or 7.1 per cent, of which approximately $1,100,000 appears to have been created through new business, and $1,000,000 by an advance of 2.1 cents in the average gross receipts per message. At the end of the 1905 year the company had $593,514 greater current liabilities than current assets. On June 30 last the balance had turned to a credit item of $3,386,890, of which $3,164,616 was in cash. This is, of course, the direct result of the issuance, during the year, of $7,200,000 4 per cent convertible bonds. Another favorable factor is the persistency with which the company has kept up its maintenance charges against earnings, in spite of a very heavy increase in other operating expenses.

In the past seven years the gross receipts of the company have increased $8,097,837, or 32.7 per cent. Wire mileage has grown 400,987 miles, or 35.6 per cent. Maintenance charges per mile of wire have been considerably increased, being $3.45 per mile last year, against $2.63 per mile in 1900, a gain of 31.1 per cent. Some of the essential features in the seven years' growth are contained in the following:

	1907.	1900.	Increase.	Per Cent Inc.
Gross	$32,856,406.00	$24,758,569.00	$8,097,837.00	32.7
Operating expense	26,532,196.00	18,593,205.00	7,938,991.00	42.1
Operating ratio	80.7%	75.1%	5.6%	....
Miles wire and cable.	1,526,845	1,125,858	400,987	35.6
Maintenance	5,278,293	2,959,998	2,318,295	78.3
Main. per mile wire	$3.45	$2.63	$0.82	31.1
Av. toll per message	33.7c	30.8c	20.9c	9.4
Av. cost per message	30.2c	25.1c	5.1c	20.3
Av. profit per message.	3.5c	5.7c	22.2c	...

*Decrease.

President Robert C. Clowry says that the increase in operating expenses is due to the necessary outlay to care for the large number of messages handled, to the increase of 10 per cent in salaries of all the operators, which went into effect last March, and to the continued high prices of materials.

WESTERN ELECTRIC FINANCES.—Official announcement is made that the Western Electric Company will create a bond issue of $15,000,000. The directors have called a special meeting of the stockholders, which will be held in Chicago on Nov. 5 for the purpose of ratifying the proposition made by the board. The belief prevails that the company is preparing to increase its business and perhaps to engage in some other branches of the electrical line. This may involve the purchase of other interests, although the possibilities of this theory are not conceded by its officers. President E. M. Barton says that the bonds probably will not be sold for some time. In 1906 the Western Electric's gross sales aggregated $69,245,331, to finance which necessitated the piling up at one time during the year of a floating debt of $24,000,000. The company has at present but $15,000,000 capital stock outstanding, so that the percentage of gross sales to capitalization in 1906 was 461 per cent. How much of an anomaly there was in this situation, says the *Wall Street Journal*, may be judged by the following comparison of the gross sales and capitalization of the three large electrical companies during their last fiscal year:

Company.	Gross sales.	Capital.	Gross to cap.
Western Electric	$69,245,331	$15,000,000	461%
General Electric	60,483,659	66,455,550	91%
Westinghouse Electric	34,170,647	48,274,150	70%

The above comparison makes no allowance for the floating debt which the Western Electric was obliged to accumulate. This debt has been reduced through payments made by the telephone companies for supplies, and now stands at about $16,000,000. Adding to the $15,000,000 of stock $15,000,000 of floating debt, which probably represents a fair average for the year, gives a total of $30,000,000 "capitalization," and makes the percentage of gross sales to "capitalization" 230 per cent.

TELEPHONE SALE.—The United States Independent Telephone Company has sold its holdings in the Home Telephone Company, of Jamestown, N. Y., to a group of Jamestown capitalists, represented by Arthur C. Wade, of Jamestown. Negotiations looking to this sale were begun last winter. It is said that the Consolidated Telephone Company, of Buffalo, and the Jamestown Company, through the Inter-Ocean Telephone Company, a long-distance subsidiary of the Consolidated, will hereafter hold a close working agreement as a result of this sale.

CANADIAN GENERAL ELECTRIC.—A special meeting of the shareholders of the Canadian General Electric Company will be held Oct. 23 to amend the by-laws recently passed to issue $2,000,000 preference stock having priority of claim over the common stock in the matter of dividends. English capitalists, who will take the bulk of the stock, have demanded for the new stock having this preference a priority also in the matter of assets of the company.

DIVIDENDS.—The Boston Edison Company has declared the regular quarterly dividend of 2½ per cent, payable Nov. 1. Directors of the Mexican Telephone & Telegraph Company have declared the regular semi-annual dividend of 2½ per cent, payable Nov. 1.

BELL TELEPHONE STOCK.—Application has been made to the New York Stock Exchange to list $21,925,300 additional capital stock of the American Telephone & Telegraph Company.

GENERAL NEWS

Construction News.

DECATUR, ALA.—The North Alabama Traction Company is contemplating further extensions and improvements to its street railway system in Decatur, which will involve an expenditure of about $10,000.

JACKSON, ALA.—The Jackson Light & Power Company has perfected organization and will purchase and enlarge the present electric light plant, and will furnish energy for the proposed water works system, and also for several gravel pits near the city. It is proposed to construct a dam across Bassett's Creek, where a 35-foot head of water may be secured and about 600 horse-power developed. The capital stock of the company is $16,000, with the privilege of increasing it to $20,000. The officers are: B. H. Warren, president; S. H. Andrews, vice-president, and S. A. Stewart, secretary and treasurer.

EUREKA SPRINGS, ARK.—The plant and holdings of the Citizens' Electric Company have been purchased by a syndicate organized by George Sengel and George Tilles, of Ft. Smith. The company operated the street railway system, electric light plant and ice plant. It is said that the electric line will be extended south three miles to the lake, where a club house will be built, and also to Beaver, a distance of six miles, where an amusement park will be established. The following officers have been elected: George Sengel, president and treasurer; George Tilles, vice-president, and L. P. Miles, secretary, all of Ft. Smith.

PINE BLUFF, ARK.—The Central Arkansas Electric Railways Company is contemplating the construction of an electric power plant to operate its proposed railway. The present plan is to purchase coal mines and build the power plant at the mines, but as yet nothing definite has been decided upon. A. M. Van Auken is chief engineer.

ALAMEDA, CAL.—F. E. Browning, city clerk, writes that it is proposed to erect a fireproof building for the municipal electric light plant and install some new machinery.

BADITO, CAL.—The Southern Colorado Power Company has been incorporated to construct a reservoir and water power plant on Huerfano River at Badito. The plant will have a capacity of about 10,000 horsepower and will supply electricity to all the towns and mines in the vicinity of Badito. It is probable that the company will furnish electric energy to operate the mines of the Colorado Fuel & Iron Company.

CHICO, CAL.—L. D. Macy has applied to the City Council for a franchise to construct and operate an electric lighting, heating and power plant in this city for a term of 50 years. Mr. Macy owns water rights on Little Chico Creek, near West Branch, and contemplates erecting a plant at that place.

ENCINAL, CAL.—Plans are being made by the Northern Electric Railway Company to erect a freight and passenger depot and a substation at this place. The power house is now located in a portable car used for installing power-house machinery.

EUREKA, CAL.—The North Mountain Power Company has recently secured additional water power in Trinity County by another high head located on Canyon Creek, a tributary to the main Trinity River. The company is now building another large plant near this new head, which has a fall of 1200 feet, and is located 16 miles above the present power station at Junction City. The new plant when completed will have a minimum capacity of 14,000 horse-power. H. L. Jackman is superintendent of the company.

FRESNO, CAL.—The San Joaquin Light & Power Company has been awarded contracts for furnishing electricity to the Redbanks Orchard and other orchards and farms in Antelope and Stone Coral country for pumping water. The company is making arrangements to obtain franchises for its transmission line, work on which will commence at once. The line will be extended from Dinuba.

GLENDALE, CAL.—The right of way has been granted and a bonus subscribed for an extension of the Los Angeles-Pacific Railway from the Eagle Rock line to the centre of Glendale. Work will soon commence on the construction of the line.

MONTEREY, CAL.—Extensive improvements and extensions are being made to the power plant of the Monterey Gas & Electric Company at a cost of $100,000.

NEVADA CITY, CAL.—Work has been abandoned for the season on the Deer Creek power plant of the California Gas & Electric Corporation owing to the company not being able to secure water pipe.

OROVILLE, CAL.—The Southern Pacific Company is said to have purchased water rights on the Robinson place near Oroville, where 10,000 horse-power can be developed.

PASADENA, CAL.—A franchise for a double-track railway was awarded to the Pacific Electric Railway for $5,000.

PASADENA, CAL.—Heman Dyer, city clerk, writes that there is talk of calling an election to vote on the proposition to issue bonds for an addition to the municipal electric light plant. Charles C. Glass is manager of the plant.

SAN BERNARDINO, CAL.—The Rialto Electric Light Company is making plans to erect a substation in this place and a transmission line from the plant of the Edison company to connect with its system in this city. The company has elected the following officers: I. C. Boyd, president; A. B. Paddock, vice-president, and I. F. Martin, secretary.

SAN DIEGO, CAL.—The City Council has granted a franchise to the Point Loma Electric Railway Company to construct and operate a street railway system on certain streets of the city.

SAN FRANCISCO, CAL.—Plans have been completed by the Southern Pacific Company for another large extension of its local system, consisting of an electric railway to Hayward.

SAN JOSE, CAL.—The Board of County Commissioners has granted J. A. Belloli permission to erect transmission lines or underground conduits over roads and public highways in the townships of Milpitas, Alviso, Santa Clara and all that part of San José township extending south as far as the northern limits of the city of San José. The franchise is for 50 years.

YREKA, CAL.—The Siskiyou Electric Power Company has installed another 1500-hp generator at the Fall Creek plant, which gives the plant a capacity of 2200 horse-power. Another generator of 1500 hp will soon be added to the plant.

ESSEX, CONN.—The citizens on Oct. 7 voted to accept the proposition offered by the Essex Light & Power Company to light the streets from Essex steamboat dock to Ivoryton. The company offers to supply 47 lamps at $1,259 per year for a three-year contract.

HARTFORD, CONN.—The Park Board has granted the Hartford Electric Light Company permission to lay a conduit across Lafayette Park.

TORRINGTON, CONN.—The W. W. Mertz Company, which has operated its own electric light plant for 15 years, is making arrangements with the Torrington Electric Light Company for service.

DUBLIN, GA.—An election will soon be held to vote on the proposition of issuing $60,000 in bonds to improve the water and light plants.

FITZGERALD, GA.—A franchise has been granted to C. A. Holtzendorf and associates to construct and operate an electric railway on certain streets in Fitzgerald. The franchise is for a term of 40 years.

MADISON, GA.—The citizens on Oct. 7 voted in favor of issuing $50,000 in bonds for water works, sewerage and improvement of the municipal electric light plant.

OROFINO, IDAHO.—Plans are being made for the installation of a water and electric light plant at Orofino at a cost of about $12,000. F. G. Lynch is interested in the project.

BUNKER HILL, ILL.—The Wood River, East Alton & Bunker Hill Traction Company is contemplating the construction of an electric railway from Wood River through East Alton, Bethalto, Moro and Bunker Hill, a distance of 20 miles. The Rude Engineering Company, of East St. Louis, is in charge of the engineering work. J. T. W. Rudisill is president of the traction company.

CHICAGO, ILL.—Application has been made to the Secretary of State by Fred W. Blocki, William F. Brennan, Jeremiah P. Bartholow, James P. Early and Kurt Stoehr to incorporate the Chicago Heat, Power & Refrigerating Company. The capital stock of the company is placed at $10,000. An ordinance asking for a franchise to operate in the streets of the city will soon be presented to the City Council by the company.

NASHVILLE, ILL.—New machinery is being installed in the plant of the Nashville Electric Light Company. Owing to the great increase in demand for electricity it has been necessary to increase the capacity of the plant. K. A. Steinhauser is manager.

CENTERVILLE, IND.—The Council is contemplating establishing a lighting plant.

EAST CHICAGO, IND.—The sale of the property by a master in chancery of the East Chicago Water Works Company and the East Chicago Light & Power Company, practically one concern, has been confirmed by the Federal Court. The property was bid in by the bondholders to be taken over by the East Chicago & Indiana Harbor Water Company and the Indiana Harbor & East Chicago Electric Company, recently incorporated. It is understood that the city received $154,000 for its interest in the plant and for a new franchise for the two new companies. The city will also receive certain concessions for light and water.

EVANSVILLE, IND.—Bids will be received until Oct. 28 by the Board of County Commissioners for wiring the new county infirmary building. Harry Stinson is county auditor.

MADISON, IND.—Capitalists of this city, headed by Richard Johnson, Edward and William Powell, are organizing a company, the object of which is to purchase outright the plant and holdings of the Madison Lighting & Electric Railway Company, which is now owned by Indianapolis and Chicago parties. The company holds the municipal lighting contract.

FT. DES MOINES, IA.—Bids will be received until Nov. 1 by Captain

MARSHALLTOWN, IOWA.—The business men of Marshalltown have agreed to subscribe $25,000 for the Melbourne interurban project, promoted by Hamilton Browne. It is expected that the banks here will take over another $25,000, and if they do Mr. Browne agrees to build the road. A 3 per cent tax has already been voted to aid the project, but to get the tax the road must be built and in operation by July 1, 1908.

COVINGTON, KY.—The Board of Aldermen has agreed to a proposed contract with the Union Light, Heat & Power Company for lighting the streets of the city and furnishing electricity for private purposes, which will be submitted to the Council for consideration. Under the terms of this contract the company is to furnish 2000 cp arc lamps at $65 per lamp per year, with a rebate of $5 per lamp if the contract is renewed at the end of the year, providing more than 380 and less than 450 lamps are used, or $10 per year in case more than 450 lamps are used. The contract also provides for 32-cp incandescent lamps at $27 each per year. A reduction of about 10 per cent has been made in the cost of electricity for private use and a list of discounts will be allowed, according to the amount of the bills, as follows: From $1 to $10 a month, 10 per cent; from $10 to $15, 15 per cent; from $15 to $30, 20 per cent; from $30 to $50, 25 per cent; from $50 to $75, 30 per cent; from $75 to $100, 35 per cent; from $100 up, 40 per cent.

GEORGETOWN, KY.—The City Council has decided to enter suit against the Georgetown Water, Gas, Electric Light & Power Company to annul its franchise, or compel compliance with its contract, which it is charged that it has violated in both light and water service.

LATONIA, KY.—Bids were opened recently for a thirteen-year exclusive franchise for electric lighting as follows: Dr. R. Lee Bird agrees to furnish lamps, 2000 cp, for $59 per lamp per year; incandescent street lamps of 32 cp for $24 each per year; commercial lighting, 9 cents per kw-hour, with a discount of 5 per cent on cash payments. The Kentucky Electric Company will furnish any number of lamps for the first three years at $60 per lamp per year and during the remaining ten years for $58 per lamp per year; any number of 32-cp lamps during the thirteen years for $24 each per year; electricity for commercial purposes, 10 cents per kw-hour, less 15 per cent for payment within ten days; for power and heat, 10 cents per kw-hour, less 20 per cent discount for payment within ten days after date of the monthly bill. In addition to the proposition for light, heat and power the Kentucky Electric Company agrees to give the village the ground on which the Cincinnati, Newport & Covington Railway & Light Company is operating after leaving Madison Avenue to the tunnel under the Louisville & Nashville Railroad tracks to be used for street purposes and in order to avoid the payment of toll on the Madison Pike. In addition $1,000 will be given toward the construction of the street and $5,000 is offered toward the expenses of constructing subways under the car tracks. The company has made these propositions in order to secure the adoption of plans that will prevent the street cars passing over the steam railroad tracks and to increase the facilities of transportation on the electric lines between Latonia and Cincinnati.

PADUCAH, KY.—Bids will be received until Oct. 18 by the Board of County Commissioners, at Paducah, to install steam heating and electric light system in the county court house and jail.

BUCKSPORT, ME.—The Penobscot Bay Electric Company, which is building a power house at East Orland, is making surveys of the country in this vicinity under the charge of Engineer W. F. Greenleaf, of Boston, Mass., and expects to set the poles to Orland at once. They also contemplate opening an office in the village soon.

MILO, ME.—The Milo Electric Light & Power Company has been granted permission by the town officials to operate a steam engine in its new power station.

BALTIMORE, MD.—Charles L. Stockhausen, of Baltimore, has secured the contract for the construction of the power house for use of the Dr. Samuel Leon Frank Memorial Hospital. Boilers, electric and laundry machinery will be installed.

CONOWINGO, MD.—Plans are being made by capitalists, headed by James H. Harlow, president of the Conowingo Bridge Company, for utilizing the Susquehanna River with another large dam to generate electricity to supply Baltimore, Philadelphia and other markets. The plant will be erected at Conowingo, near Havre de Grace, Md., about nine miles above the mouth of the river. The plant will have a capacity of 100,000 horse-power. The company is capitalized at $10,000, and bonds to the amount of $10,000,000 will be issued. The five turbines in the old paper mill will be utilized to generate electricity for lighting and operating purposes during the construction work. An electric railway will also be built from the reservoir site to Havre de Grace to handle material, etc., for construction work.

OAKLAND, MD.—The Youghiogheny Light & Power Company, which was recently incorporated to erect a power plant below Deep Creek Falls to furnish electricity in Oakland, Mountain Lake and other towns in Maryland, West Virginia and Pennsylvania, has been organized, and the following officers elected: Alfred G. Sturgiss, president; Truman West, vice-president; Bowie Johnson, secretary; James D. Hamill, treasurer, and Hiram P. Tasker, general manager.

CHARLEMONT, MASS.—The Frary Manufacturing Company is installing a dynamo to operate its own electric lighting plant.

CHICOPEE, MASS.—The Chicopee Manufacturing Company is installing an additional generator in its power plant, which will enable the company to operate its manufacturing plant at its full capacity at all seasons of the year as well as to operate the new machinery which is now being installed. The machines are operated by individual motors, of which 20 have already been installed, and 30 more will be added to the plant.

NEWBURYPORT, MASS.—The Newburyport Gas & Electric Company is installing an additional engine and generator, which will increase the capacity of the plant by 550 horse-power, to provide for the increasing demand for electricity for commercial work. Two new panels will be added to the switchboard and a new auxiliary condenser will be among the other additions made to the plant. It is expected to have the work completed by Nov. 1.

ORANGE, MASS.—Negotiations and plans are under way whereby the Rodney Hunt Machine Company will purchase the water power privileges of E. S. Handy at Eagleville, two miles distant from the company's plant. The company proposes to utilize the water power to generate electricity to operate the machinery in the Rodney Hunt shops in place of steam, which is now being used.

BAY CITY, MICH.—Bids will be received until Oct. 30 by the City Controller for furnishing a steam turbine, generator, exciter, switchboard, boilers, Scotch type, and lamps, to re-establish the city's electric light plant. Albert Boston, Deputy Recorder, writes that specifications have been prepared, and bids will probably soon be called for by the City Controller for dismantling the east side electric light plant and re-establishing same on the west side. William H. Fitzhugh is superintendent.

BIRMINGHAM, MICH.—The Detroit United Railway Company is making arrangements to enlarge the power house to make room to install additional machinery in the plant.

BOYNE CITY, MICH.—The dam of the Boyne River Power Company has been completed and the plant has been put into operation and is furnishing electricity for lighting the streets of the city.

CENTRALIA, WASH.—B. J. Weeks, of Tacoma, is interested in a project to build an electric railway between Centralia and Chehalis, to be known as the Centralia, Chehalis & Western Railway, a distance of eight miles, and a branch line of two miles to a freight centre. It is stated that $150,000 worth of bonds has been subscribed.

GRAND RAPIDS, MICH.—At an election held recently the citizens voted in favor of granting a new franchise to the Grand Rapids-Muskegon Power Company. The company is making plans of extensions to its system in the city.

MANCHESTER, MICH.—A special election will soon be held to vote on the proposition of the village establishing a municipal electric light plant.

COLD SPRING, MINN.—The Minnesota Central Telephone Company is contemplating extending its lines to Avon.

ST. PETER, MINN.—Plans are being considered for extensive improvements to the municipal electric light plant. Several hundred dollars will be spent on repairs to the pole lines, and it is proposed to increase the capacity of the plant by the installation of new dynamos. When improvements are completed a day power service will be furnished to local manufacturers. The plant has proven a paying investment ever since it has been in operation, and it is expected that the adoption of the new plan will materially increase the receipts.

COLUMBUS, MISS.—The Fayette Telephone Company, of Fayette, Ala., has applied to the City Council for permission to erect poles and wires in the streets of Columbus.

PHILADELPHIA, MISS.—The Philadelphia Compress Company is contemplating installing an electric lighting plant. Contracts have not yet been placed for machinery and supplies.

ST. LOUIS, MO.—The Union Electric Light & Power Company, of St. Louis, a subsidiary corporation of the North American Company, will presently increase its capital stock from $10,000,000 to $18,000,000. Stockholders will meet Dec. 2 to ratify the action of the board in recommending the increase.

AURORA, MO.—The Aurora Light, Power & Refrigerator Company, recently incorporated, will erect a new building and install new machinery at a cost of about $25,000. J. R. Woodfill, Jr., is president and treasurer; S. E. Post, vice-president, and J. M. Hawkins, superintendent.

STEVENSVILLE, MONT.—H. C. Hodge, of Tacoma, Wash., is reported interested in the construction of an electric light plant to furnish electricity to light Stevensville and Victor. Mr. Hodge is planning to develop the water power in the Big Creek Canyon west of Victor.

PLATTSMOUTH, NEB.—Earl C. Wescott has been granted a franchise to construct an electric light plant.

NASHUA, N. H.—The Nashua Street Railway Company has applied to the State Board of Railroad Commissioners for permission to issue $25,000 of capital stock.

COLLINSWOOD, N. J.—Application has been made to the Borough Council for franchise privileges for lighting the borough and supplying it with water. The company, which is to be known as the Collingswood Mutual Water Improvement, agrees to furnish eight arc lamps for lighting the borough at a charge of not more than $70 per lamp per year and $20 per lamp per year for 75 incandescent lamps, and agrees to extend its lines to any part of the borough. The company also agrees to sell both the lighting and water plants to the borough during a term of five years upon payment of 10 per cent over the actual cost of the plants.

CLIFTON SPRINGS, N. Y.—Ford S. Burgett, who is interested in the organization of a company to develop a water power and to furnish electricity for lighting this and nearby villages, writes that plans are now being drawn up and will be presented to the Village Board for consid-

eration, and that bids for the work will be received about Nov. 1, the cost of which is estimated at $16,500.

FLUSHING, N. Y.—Bids will be received by C. B. J. Snyder, superintendent of school buildings, New York City, until Oct. 21 for installing heating and ventilating and electric generating apparatus and electric elevator in the Parental School in Flushing, Borough of Queens.

NEW YORK, N. Y.—Bids will be received until Oct. 21 by C. B. J. Snyder, superintendent of school buildings, New York City, for installing electric equipment in additions to and alterations in School 59; also in connection with alterations in School 171, both in Borough of Manhattan.

ONEIDA, N. Y.—The Board of Trustees of Sylvan Beach has granted Peter Kippal, of Buffalo, a franchise to erect and operate an electric light plant in Carnival Park. Mr. Kippal will furnish electricity for lighting purposes to business places and residences at $1 per lamp of 16 cp per month, or $2 for the season. He also proposes to build a scenic railway on the park to be operated by electricity.

ROCHESTER, N. Y.—The United States Independent Telephone Company has sold its holdings in the Home Telephone Company, of Jamestown, N. Y., to a group of Jamestown capitalists, represented by Arthur C. Wade, of Jamestown. It is said that the Consolidated Telephone Company, of Buffalo, and the Jamestown company, through the Inter-Ocean Telephone Company, a long distance subsidiary of the Consolidated, will hereafter hold a close working agreement as a result of this sale.

STATESVILLE, N. C.—The Southern Power Company, of Charlotte, has completed its transmission line to this place and is now constructing a substation. As soon as the station is completed a 24-hour service will be furnished. Several of the manufacturing industries will use electricity to operate their plants.

VALLEY CITY, N. D.—Plans have been made to enlarge the municipal electric light plant, and contracts placed for a new boiler and dynamo.

CINCINNATI, OHIO.—Surveys have been completed for the proposed route of the Cincinnati, Reading & Middletown Street Railway Company from Middletown and Franklin to Bond Hill and Norwood, a distance of 35 miles. It is estimated that the road will cost $875,000.

EUGENE, ORE.—A. G. Hendricks, president of the National Bank of Eugene, and F. L. Chambers, president of the Chambers-Bristow Bank, have filed on 100 miner's inches of water under six inches pressure in the McKenzie River at Haydens Rapids, seven miles northeast of Eugene. The canal will run through solid rock and will be 50 feet wide, 20 feet deep and 700 yards long.

EUGENE, ORE.—The Pacific Light & Power Company has awarded a contract for 100,000 feet of lumber with which to build the flume for a large electric plant which it intends to erect near Triangle Lake, 30 miles west of Eugene. It is the intention to build the flume this winter and erect the plant next spring and summer. The company plans to extend its lines to Eugene, Corvallis and Junction City and other towns in the valley. The company has appropriated 50,000 miner's inches of water of the lake.

PORTLAND, ORE.—The United Railways will soon make application to the county court for a franchise for a broad gauge electric railway from Portland through Linnton to the county line, to construct and operate the same as part of the interurban system which the company is installing.

ALLENTOWN, PA.—The Arbogast & Bastian Company has purchased electrical equipment and machinery from the Lehigh Electric Company to operate its plant by electricity. The machinery consists of a 225-hp Murray Corliss engine direct connected to a 125-kw generator and a new switchboard and other electrical equipment.

ALLENTOWN, PA.—The power house at Broadhead station, which has furnished electricity for operating the Bethlehem & Nazareth Electric Railway ever since it was built, has been abandoned. Electric energy for operating the road is now furnished from the storage plant at Hecktown, which is supplied from the main plant in Allentown.

ALTOONA, PA.—The Citizens' Electric Light, Heat & Power Company is installing two large boilers at its plant at Ninth Avenue and Twentieth Street, and making other improvements to increase the capacity of the plant and increase the service.

BETHLEHEM, PA.—The Town Council of Northampton Heights has awarded the contract for lighting the streets of the borough to the Bethlehem Electric Light Company for 23½ cents per lamp per night. The contract is for 10 years.

MT. CARMEL, PA.—The Citizens' Company has been organized by local business men to construct and operate an electric light plant.

PHILADELPHIA, PA.—The contract for installing three turbine-driven generators, including condenser, air pump, piping and switchboard complete at Torresdale pumping station, has been awarded to Dravo, Doyle & Company, Philadelphia, for $25,150.

HURON, S. D.—The Dakota Central Telephone Company is seeking a renewal of its franchise and proposes to establish an automatic system.

PIERRE, S. D.—Bids will be received by C. F. Larrabee, Acting Commissioner of Indian Affairs, Washington, D. C., until Nov. 4 for constructing an electric light plant and construction of a brick office building with electric light, steam heat, a brick warehouse with electric light and brick addition to the workshop with electric light and plumbing. For further information apply to J. C. Levengood, superintendent, Pierre.

BEAUMONT, TEX.—The directors of the Beaumont Ice, Light & Refrigerator Company have decided to increase the capital stock of the company for the purpose of enlarging the plant.

BEEVILLE, TEX.—E. J. Kinkler is contemplating installing an electric lighting plant, which will have a capacity of 300 lamps. Contracts for machinery have not yet been placed.

ASHLAND, VA.—The Virginia Light & Power Company has notified the Town Council that it is ready to furnish electricity for both lighting and power purposes. The system will be put into operation as soon as the plans are approved by the street committee.

MANASSAS, VA.—We are informed that all bids opened by O. E. Newman, chairman improvement committee of Council, on Sept. 28 for furnishing material and installing water works and an electric light plant and macadamizing the streets of this town have been rejected on account of the town being unable to sell its bonds. A new election will be held and after bonds are sold new bids will be called for.

ELMA, WASH.—The Elma Light & Power Company is constructing a large dam on Cloquallum Creek to utilize the water power to operate its electric plant in Elma. The present plant, which has been in operation about three years, is operated by steam.

MONTESANO, WASH.—Owing to the unsatisfactory service given by the Montesano Light & Water Company the City Council has revoked the franchise of the company. C. H. Kiehl, of Seattle, is president of the company.

PUYALLUP, WASH.—The Mayor has appointed a committee of three to look into the matter of buying or building a municipal electric light plant.

GREEN BAY, WIS.—The lighting controversy in this city is fast approaching the stage where an appeal to the rate commission will be necessary. The Council has again rejected bids of the Minahan Building Company and the Green Bay Gas & Electric Company, asserting that the figures of both for lighting the city streets are too high. The Minahan company is a new arrival in the field and agrees to furnish electricity for lighting the city at the rate of $69 per lamp per annum, which is $1 lower than the Green Bay Gas & Electric Company's offer. Bids have been rejected three times within the last year and a half, and as a result the city is getting very poor service in the residence district. The Green Bay Gas & Electric Company, present holder of the franchise, stands ready to install new lamps throughout the city and remedy the existing defects if given the franchise. In the meantime it is not furnishing service in the residence portion as a result of the Council refusing to pay in full a bill presented for lighting early in the season.

LAKE NEBAGAMON, WIS.—Owing to the shutting down of the mill the electric lamps have been removed and the streets are in darkness. A plant was installed to light the mill, and also furnish electricity for lighting the streets. The company has removed all the electric light lines and closed down the entire plant. J. P. Weyerhaeuser, former manager of the mill, has removed to St. Paul.

WATERLOO, WIS.—At a special election held Oct. 10 the citizens voted to purchase the electric light plant owned by Elizabeth Nelson, Robert Entwhistle and H. Nelson. The city will issue $10,000 in bonds to purchase the plant and for improvements.

WAUSAU, WIS.—Neal Brown states that his company is now operating five and one-half miles of its line and will ultimately extend from Schofield to Merrill via Wausau and Brokaw, a distance of 25 miles. The grading has been completed the entire distance. The company is planning to construct a water power plant at the Trappe Rapids on the Wisconsin River, about ten miles south of Wausau, where 4000 horsepower is available. Electricity for operating the road is now supplied by the Wausau Electric Company.

SARATOGA, WYO.—It is reported that the Carbon Timber Company is endeavoring to purchase the plant of the Saratoga Light & Power Company, owned by John M. Kuykendall, Harry Brown, J. M. Barker and other Denver men. If they purchase the plant they propose to operate it from the sawmill and will develop enough power to supply the Saratoga Springs bottling plant, a laundry and possibly for the proposed municipal water plant.

CALGARY, ALB.—At a recent meeting of the City Council it was decided to at once call for tenders for the construction of the municipal street railway system. Address City Engineer Thorold or Mayor Cameron.

OLDS, ALB.—The Board of Trade is arranging to secure expert opinion on the development of power at Little Red Deer, 13 miles distant. Address S. Craig, Olds.

KELOWNA, B. C.—The ratepayers have passed a by-law authorizing the raising of $40,000 by the sale of debentures for waterworks and electric light plants. Address J. F. Burne, Kelowna.

VANCOUVER, B. C.—The directors of the British Columbia Electric Railway Company have voted to expend $1,000,000 for extension and improvements to its system during 1908. R. N. Sperling, of Vancouver, is general manager.

CARNDUFF, CAN.—Mr. Stinsell, representing the Minneapolis Street & Town Lighting Company, Minneapolis, Minn., has applied for a franchise to furnish electricity for light and power and to install a telephone system in the town.

PORTAGE LA PRAIRIE, MAN.—The directors of the Central Electric Light Company have decided to spend $35,000 on enlarging their power plant. The company offers to double the number of street lamps if the town will extend the street lighting contract.

WOODSTOCK, N. B.—The Woodstock Electric Light & Power Company is contemplating changing its plant from direct to alternating current.

CHIHUAHUA, MEX.—It is announced that more than $1,000,000 will be spent in constructing the new electric railway system in this city and the suburban lines to Santa Eulalia and to the new smelter of the American Smelting & Refining Company, 16 miles distant from the town. Enrique Greel is the principal owner of the company.

LINARES, MEX.—José Benilla, of this city, has purchased the local street railway system. It is said that he will greatly improve the lines and will build extensions to two smaller towns in this section.

MEXICO CITY, MEX.—The city of Mexico has decided to operate the water works pumping stations by electricity, and the contracts for the machinery have been awarded to the Westinghouse Electric & Manufacturing Company, of Pittsburg, Pa. The plans call for three large motors of 1200 hp each, which are to be direct connected with centrifugal pumps at the pumping station. The Mexican Light & Power Company will furnish electricity for operating the water works system.

OAXACA, MEX.—Eduardo J. Cummings, of Guanajuato, has secured concession grants to use 30,000 liters of water per second on the Quiotepec River, near Tomellin. A fall of 400 feet is available and 48,000 horse-power can be developed. It is proposed to install a hydro-electric plant and to transmit electrical energy to Oaxaca and the mining camp of Taviche and intervening towns to the north as far as the city of Puebla and south to the towns of San Antonia, Tehuacan, Tlacotepec, Tecamachalco and Tepeaca. The length of the transmission line to Puebla will be 130 miles, and the line to Oaxaca 70 miles, and to Taviche 30 miles.

SALTILLO, MEX.—A number of capitalists, headed by Guillermo Velasco and Rodolfo Garza, have organized a syndicate to construct an electric railway in this city.

SULTEPEC, MEX.—The Sultepec Electric Light & Power Company has completed the installation of its large power plant at Temascaltepec, and also its 25,900-volt transmission line to Sultepec, where a substation has been built. The company furnishes electricity to many mines and mills.

VERA CRUZ, MEX.—The Vera Cruz Electric Light & Power Company has completed arrangements to provide the city with electric traction in addition to its lighting and power service. The power plant is being greatly enlarged and the work of rebuilding the tracks will soon commence.

New Industrial Companies.

THE FOLLETT TIME-RECORDING COMPANY, of New York, N. Y., has filed articles of incorporation with a capital stock of $300,000. The directors are: Albert Blackburne, Edward W. O'Meara and Thomas Dowdell, all of New York City.

THE SAVITZKY & GOLOMB COMPANY, of New York, N. Y., has been incorporated with a capital stock of $20,000 for the purpose of manufacturing gas and electric fixtures. The directors are: Louis Savitzky, Miles Rosenluth and Isaac M. Golomb, all of New York, N. Y.

THE WESTERN ELECTRIC COMPANY, of Cincinnati, Ohio, incorporated recently with a capital stock of $50,000, is said to be successor to the Standard Electric Company. The charter of the new company gives it authority not only to handle and sell electrical equipment, but to operate telephone, telegraph and electric light and power plants. This part of the business will not be taken up, however, according to present intentions. The incorporators are: Eldon R. James, Stanley M. Withrow, Fred F. Downs, W. S. Berry and L. T. Miller.

New Incorporations.

EATON, COL.—The Eaton Electrical Company has been incorporated with a capital stock of $25,000 by W. A. Farr, Roscoe Farr and others. The company proposes to furnish electricity for light, heat and power in Eaton.

CHICAGO, ILL.—A charter has been granted to the Western Illinois Electric Traction Company by the Secretary of State. The company is capitalized at $100,000 and proposes to construct a railway from the town of Lyons to Aurora. The incorporators and the first board of directors are: M. M. Miller, Edmund J. Schmidt, Louis Crollan, Lee Michael and William Klein.

FARMERSBURG, IND.—The Tarr Electric Company, of this city, has filed articles of incorporation with the Secretary of State. The capital stock is $20,000. The object of the company is to construct and equip a new plant to generate electricity for light, heat and power purposes. The directors are: A. D. Tarr, W. F. Baldridge and E. W. Jennings.

INDIANA HARBOR, IND.—The Indiana Harbor & East Chicago Electric Company has been incorporated by H. H. Philips, R. M. Cole, H. S. Oakley and C. B. Woods. The company proposes to erect and operate an electric plant to supply the city of East Chicago and other cities and villages along its lines with electricity for lighting, heating and power purposes.

MUSKOGEE, I. T.—The Falls Construction Company has been incorporated by E. A. Hill, P. L. Soper, S. M. Rutherford, Ira L. Reeves and J. M. Brogan. The company has been formed to construct the Muskogee Navigation Electric Railway from Muskogee to Fort Smith, Ark. The present plan is to utilize the water power of the Grand River to operate the railway.

CLINTON, IA.—The Wenatchee Valley & Northern Railway Company has filed articles of incorporation with the Secretary of State. The capital stock of the company is placed at $100,000, and the officers are L. Lamb, president; C. R. Lamb, vice-president; Petrel Davis, treasurer, and G. E. Lamb, secretary, all of Clinton.

WEBSTER CITY, IOWA.—Articles of incorporation will soon be filed for the Boone, Webster City & Northern Railway Company. The company will be capitalized at $600,000, which, it is said, will be sufficient to build and equip the road, which will be 31 miles in length and connect Boone and Webster City. The officers of the company will be: E. E. Hughes, of Boone, president; F. A. Sackett, of Webster City, vice-president; J. S. Crooks, of Boone, secretary; J. H. Herman, of Boone, treasurer.

ALEXANDRIA, LA.—The Kent Company, Ltd., has been chartered with a capital stock of $100,000. The company proposes to operate electric and other street railways. The officers are: A. Albert, president; William M. Cady, vice-president; Benjamin Weil, secretary and treasurer.

SEMINARY, MISS.—The People's Telephone & Telegraph Company has been organized with a capital stock of $10,000, and will be ready for service within a short time.

AURORA, MO.—The Aurora Light, Power & Refrigerator Company has been incorporated with a capital stock of $50,000 by J. M. Hawkins, C. K. Gimlerling, Mrs. E. J. Martin and others.

EAST WORCESTER, N. Y.—Articles of incorporation have been filed for the Great Bear Light & Power Company with the Secretary of State. The capital stock is placed at $20,000, and the company proposes to operate in the counties of Otsego and Schoharie. The incorporators are: James E. Dante, A. D. Hallenbeck and Lucy Dante, of East Worcester.

MT. VERNON, N. Y.—The Mount Vernon & Eastern Railroad Company has been formed with a capital of $1,000,000 to construct a steam or electric railway from Mount Vernon to Lewisboro, a distance of 35 miles. The directors are: Oakleigh Thorne, William H. Chesbrough, Carleton Bunce, Howard K. Wood and Charles E. Mitchell, of New York, N. Y.; Marsden J. Perry, of Providence, R. I.; George H. Hansel, of Cranford, N. J.; Kennett K. McLaren, of Jersey City, N. J., and Allen Wardwell, of Lawrence, N. Y.

MANGUM, OKLA.—A charter has been granted to the Southwestern Interurban Railway Company to build an interurban railway from Mangum to Hollis by the way of Francis; to Granite and Cordell, with a branch from Granite to Hobart, and from Mangum to Altus, the total mileage being 119 miles. The capital stock of the company is placed at $1,000,000, and the directors are W. T. Funderburk, D. J. Doyle, E. E. Pinkerton, T. P. Clay, H. M. Ferguson and R. C. Echols, all of Mangum.

OKLAHOMA CITY, OKLA.—The Oklahoma City Central Interurban Railway, Telephone, Telegraph, Light & Power Company has been chartered for $5,000,000 with headquarters in this city and at South McAllister, I. T., to build an electric line westward from South McAllister, via Holdenville, Wonoka and Shawnee to Oklahoma City, then to El Reno, Geary and Weatherford to Cheyenne in Roger Mills County. The incorporators are C. D. Freeman, of Denver, Col.; Leon Brown, of St. Louis, Mo.; B. F. Sharp, of Memphis, Tenn.; G. M. Watson, of Nevada, Mo.; Louis Landsman, of Jefferson City, Mo.; Dr. R. N. Wade, J. B. Bloucher, F. M. Stone and H. H. Codington, of Weatherford, Okla.

OKLAHOMA CITY, OKLA.—The Oklahoma City Electric Terminal Company has been granted a charter with a capital stock of $2,500,000. The incorporators are Guy V. McClure, Charles Combs, Warren E. Moore, J. J. Johnson and Fred S. Combs. The company proposes to build a street railway system on both the east and west side of the city; the two divisions of the system will give about 12 miles of service. Application will soon be made to the City Council for a franchise.

NASHVILLE, TENN.—The Rock City Electric Company has been incorporated with a capital stock of $10,000 by John A. Bell, Louis Leftwich, Hamilton Parks and others.

LUBBOCK, TEX.—The Staked Plains Telephone Company has filed articles of incorporation with a capital stock of $60,000 by C. W. Alexander and others.

KENT, WASH.—The Independent Telephone & Telegraph Company has been incorporated with a capital stock of $270,000 by A. T. West and others.

ELKINS, W. VA.—The Elkins Power Company has been incorporated with a capital stock of $75,000 by Stephen B. Elkins and others.

WELLSBURG, W. VA.—The Bethany Trolley Syndicate has been chartered with a capital stock of $10,000 to construct an electric railway from Wellsburg to Bethany, and to maintain a power plant and water works system. The incorporators are: J. L. D. Queen, R. M. Addleman, H. O. Moon, B. S. Honecker and C. J. Schuck, all of Wheeling.

MATTOON, WIS.—The Mattoon Telephone Company has been organized with a capital stock of $2,500 by Theodore Kroz and others.

PARDEEVILLE, WIS.—Articles of incorporation have been filed for the Pardeeville Telephone Company by Frank H. Smith and others. The company is capitalized at $4,000.

POYNETTE, WIS.—The Poynette Telephone Company has been incorporated with a capital stock of $10,000 by E. E. Hinkson, J. S. Hinkson and H. P. Jamieson.

Legal.

SALE OF ELECTRICAL ENERGY.—An important decision was handed down last week by Supreme Court Justice Fitzgerald by which it is held that the Interborough Rapid Transit Company and the New York City Railway Company must pay the city of New York for energy used by the latter company in running the surface cars operated in connection with the subway. The court also restrained the Interborough Company from delivering electrical energy to the City Railway Company, and the latter company from using, disposing of, or selling the energy so obtained. An interlocutory judgment was also issued on condition that an immediate appeal be taken by the two railway companies from the decision. The action was brought last November by the Board of Rapid Transit Commissioners, who asserted that the Interborough Company, which operated the subway, was violating the provisions of its contract with the city in supplying electricity to a subsidiary corporation which operated surface cars running from the Bronx to the upper part of Manhattan. Justice Fitzgerald appointed ex-Supreme Court Justice Edward Clinch as referee to compute the amount due to the city by the defendant companies for their misuse or appropriation of the electric energy.

RIGHT OF LOCAL TELEPHONE COMPANY TO CONNECT WITH THE LONG DISTANCE WIRES OF ANOTHER COMPANY.—The Billings Mutual Telephone Company, a local concern operating some 350 telephones in the vicinity of Billings, Mont., after attempting to make an agreement with the Rocky Mountain Bell Telephone Company by which it could connect with the latter company so as to be able to transmit messages over its long distance lines, brought an action to compel the Rocky Mountain Company to permit such a connection. The defendant answered by admitting that the connection with and use of defendant's lines by the plaintiff would increase the revenue of the plaintiff and accommodate its customers, but it denied that the use of defendant's lines by plaintiff was necessary to the proper operation of the telephone line of the plaintiff and alleged among other things that such connection was desired by plaintiff to save it the great expense of building its telephone lines through the territory covered by the telephone lines of the defendant. Article 15, Section 14, of the Constitution of Montana provides that any person or corporation organized for the purpose "shall have the right to construct or maintain lines of telegraph or telephone within this state and connect the same with other lines, and the legislative assembly shall by general law of uniform operation provide reasonable regulations to give full effect to this section." Civ. Code Mont., Sec. 1001, after repeating such provision, provides that "in case such persons or corporations cannot agree as to the compensation to be paid for the privilege of such connection, the acquiring of the right by the one to use the line of the other may be had . . . as provided in the Code of Civil Procedure." It was held that under such provisions a telephone company operating a local exchange, such as the plaintiff, on payment of compensation to be ascertained as provided by the statute, could require the defendant company operating long distance lines to permit a connection with such lines and also their "use" by receiving and forwarding messages through such connection from subscribers of the other company substantially as it did messages tendered by its own local subscribers. Billings Mutual Telephone Company vs. Rocky Mountain Bell Telephone Company, United States Circuit Court, 155 Fed. Rep. 207.

DISTINCTION BETWEEN LIABILITY OF ELECTRIC COMPANY FOR MAINTAINING UNINSULATED WIRES AND LIABILITY OF RAILROAD COMPANY FOR RUNNING INTO PERSONS ON ITS TRACKS.—A telephone company employee, who had previously been a foreman, was required in the course of his employment to climb a telephone pole and, while going up the pole, received a shock of 2000 volts from a wire from which the insulation had worn, causing him to fall to the ground, a distance of about 25 ft. In an action against the telephone company it appeared from his testimony that he approached the pole, walking on a stone wall at the side of the road and that from his position it was impossible for him to detect the absence of insulation on the wire or to see a burnt place which the insulated wire had made upon the pole. There was evidence, however, that by going a short distance into the road he might have seen the defective conditions. But the fact that he did not see that there was anything wrong and that, while prior to the accident, he had been in good physical condition, he was thereafter continuously ill, it was held that a verdict of $5,200 was not excessive. It was argued that the case was parallel to certain railroad cases in which a person who goes upon a railroad track without taking the customary precaution of looking and listening is denied damages in event of his being run down by a train, but the court concluded that the cases were essentially different. In railroad cases the dangers upon a railway are so well known that failure to look and listen is as a matter of law held to be negligence; but a railroad track is for the purpose of the running of railway trains. The man who approaches it has full knowledge that such is its primary and rightful use, and the use of it by him is subject to its dominant use. On the other hand, the man who climbs a telephone pole is not charged with knowledge that its rightful use is for uninsulated and dangerous wires. He knows, on the other hand, that there is a duty to keep the wires insulated, and that, while the purpose for which the structures are used renders some danger from electrical currents unavoidable, he has some reason to expect that the wires will be kept protected. He knows, to be sure, that it is difficult to do this, and that there is liability that there may be a lack of insulation of some wire, but the risk of defective insulation varies with the circumstances and the case is not like that of a railroad track, where the danger is always well known, distinct and incident to its lawful use. Dover vs. Gloucester Electric Company, United States Circuit Court, 155 Fed. Rep. 256.

TEMPORARY INJUNCTION RESTRAINING INFRINGEMENT OF ELECTRICAL PATENT REFUSED.—In a motion for a temporary injunction restraining the infringement of a patent for an electrical safety fuse, it was complained by the plaintiff that one of the defendants had invented a new and useful improvement in fuses, upon which he had obtained a patent, and which he sold to the plaintiff for a valuable consideration. Later, and after having granted to the plaintiff all rights in the invention, the inventor, according to the claim of the plaintiff, organized a corporation for the purpose of manufacturing and selling safety fuses constructed on the same principle as that involved in the invention. The novelty covered by the invention consisted in uniting a wide, thin strip with the filling, so as to envelop completely the fuse and thus best utilize the properties of the ready fusibility and the quick dispersion of the heat of the strip when melted. The fuse consisted of a flat fused strip of metallic ribbon inclosed in a case of non-conducting fiber with metal end caps, usually of brass, to which the ends of the fusible metallic ribbon were joined by terminals, the filling material of the fuse forming a non-conductor about the fusible metallic ribbon. The defendant admitted the sale of the patent to the plaintiff, but claimed a new discovery, namely, the adjustment of a very thin, metallic ribbon with an extended area within the casing of the fuse, so thin and so extended in its area that the non-conducting material encased about it being likewise extended, thus giving such a maximum contact with the non-conducting filling material that the circuit is immediately opened when any portion of the metallic ribbon or strip becomes molten and the electrical continuity is immediately severed while in this molten condition. In fuses previously manufactured the filling material so supported the molten material that the melting of the fuse did not immediately cut the circuit, but would arc or hang, and such failure of immediate interruption of the circuit upon the melting of the ribbon or strip under the old process resulted in inaccuracy and unreliability as to its operation in the presence of "unequal current value." The court was of the opinion that this principle above set forth as the defendant's claim was the real novelty, if any, and the gist, of the invention. The defendant had not made and sold a fuse like that covered by the patent. The fuse which he made was like those in general use by other manufacturers, which are understood by the trade generally not to be covered by any enforceable patent. Soon after obtaining the patent in suit it was discovered that fuses of the patent lacked mechanical stability and ease of manufacture and that the advantages secured by it were not sufficiently superior to fuses made under the old means of manufacture to warrant the increased cost which was entailed, and therefore the plaintiff never adopted it in practical use and never marked his fuses as having been manufactured under this patent. For these reasons it was held that the preliminary injunction could not be granted. It is a well-settled rule of the law that where grave doubt arises as to what the final decree upon the merits must be, either as to fact or law, the summary power of the court to grant preliminary injunctions should not be exercised unless it may be to preserve the status quo of the parties under circumstances that will not work serious hardship to the party enjoined. It is also a settled rule of law that in acting upon applications of this sort the court "should regard the comparative injury which would be sustained by the defendant if the injunction were granted and by the complainant if it were refused." John-Pratt Company vs. Sachs Company, United States Circuit Court, 155 Fed. Rep. 129.

Educational.

HARVARD UNIVERSITY.—The electrical department of the Harvard engineering school has added a considerable amount of valuable apparatus to its equipment during the summer months. Among the most valuable is a large electric motor, which will be set up in Pierce Hall for experimental use. Another piece is a mercury arc converter. About $4,000 was expended for the new equipment, which will make a valuable addition to the demonstration work of the electrical engineering department.

Obituary.

MR. PHILIP FITZSIMMONS, president and principal owner of the Fitzsimmons Telephone Company, of Cincinnati, Ohio, was killed Oct. 8 at the home of his daughter in Birmingham, Ala., by falling from the second-story window while walking in his sleep.

MR. CHARLES ANDREW WILSON, of Sussex, N. J., died suddenly Oct. 7, at Sioux City, Ia., in the course of a Western trip. Mr. Wilson, who was born 67 years ago in the borough of Sussex, was prominent in many corporations in that part of the state. He was president of the Farmers' National Bank of Sussex, the First National Bank of Butler, the Woodburne Electric Light & Power Company, the Unionville Water Works and the Wantage Outing Club. He was an officer in many other corporations and part owner of the Sussex Independent.

Personal.

MR. A. HALL BERRY, of New York, left this week for Europe on an extended trip for both business and pleasure. Mrs. Berry accompanies him.

MR. CHARLES E. WADDELL, Biltmore, N. C., is the author of a paper printed in the September issue of the Franklin Institute, entitled "Southern Appalachian Streams."

MR. LYNN A. WILLIAMS, for the past six years assistant to Mr. Charles A. Brown, patent attorney, Chicago, has been admitted to partnership with Mr. Brown. The firm name will be Brown & Williams.

MR. ERNEST CARSTENS, who has had an experience of many years in this country and in England as an accountant, has opened an office at 56 Rose Street, New York, for practice as a public accountant and auditor.

MR. A. C. BELL, who has been in charge of the patent department of the Stromberg-Carlson Telephone Manufacturing Company, has joined the staff of Brown & Williams, patent attorneys, Chicago. Mr. Bell will give attention chiefly to the work of patent soliciting.

MR. WILLIAM A. JACKSON has resigned from the presidency of the Michigan State Telephone Company and has been elected president of the executive committee, a place left vacant since the death of William C. McMillan. Mr. N. C. Kingsbury, former vice-president, was appointed president to succeed Mr. Jackson. Mr. B. W. Trafford has been made one of the vice-presidents and will also be general manager.

MR. ARTHUR S. MERRILL, who has been in the electrical business for the past ten years, most of the time in New York City, and who has been assistant western sales agent for Pass & Seymour, Inc., Solvay, N. Y., with headquarters at 130 W. Jackson Blvd., Chicago, for over a year, has tendered his resignation in order to carry out plans which he has had in mind for some time. He is a brother of Mr. Wm. W. Merrill, secretary of the Chicago Fuse Wire and Manufacturing Company, Chicago.

MR. J. E. FRIES, of Milwaukee, has found his services in demand since he left the Allis-Chalmers Company, and has now joined the forces of the Canadian General Electric Company as a commercial engineer. When with the Allis-Chalmers Company he was employed as electrical engineer in their contracting department. In his new capacity he will do designing and commercial engineering work for the sales department on electrical as well as mechanical apparatus.

MISS C. BECKWITH.—We note with regret the serious illness of Miss Carmelita Beckwith, who was stricken down at her desk last week while at work in the office of "Profitable Advertising," which she shared with her friend, Miss Kate Griswold, the publisher. The hemorrhage of the brain while slight has left a condition of aphasia, but her rally has been quick and it is hoped that the recovery may be complete. She was removed as soon as possible to her rooms in the Hotel Martha Washington and has since been in the hands of trained nurses. Miss Beckwith's literary-electrical work began when she was with the General Electric Company and was continued on the bulletin of the New York Edison Company. Many of her interesting articles have been contributed to the pages of the ELECTRICAL WORLD, while several of her little brochures, such as the "Electric Jingles" and "When the Sad Iron Smiled," are in wide circulation. Of late her business had grown rapidly and when taken ill she was at work on the new bulletin of the National Electric Light Association. Admired everywhere for her sunny and buoyant disposition, it is the belief of a host of friends that her youth and abundant vitality will restore this amiable and talented woman to full health.

MR. F. E. DRAKE, managing director of the French Westinghouse Company, who will shortly return to Paris, has devoted the past several weeks to conference with the officials of the Westinghouse Electric and Westinghouse Machine Companies, and has made a careful study of the latest developments of both works. He is arranging for the sale in his territory of some of the important specialties now made at the East Pittsburg works of the two companies, notably steam turbines and turbo-generators. Mr. Drake has also arranged to forward to the machine company, which owns the patents for this country, several sizes of the Leblanc condenser, in order to hasten their introduction in this country. The Leblanc condenser, after an extended use, is now considered by leading European steam engineers, because of the almost perfect vacuum secured in so simple a manner, to be one of the most scientific developments of recent years. The French Westinghouse Company, by reason of its control of the Leblanc inventions, is already doing an important business in their manufacture and sale, which is adding to the net profits of the company, which, for August, exceeded the monthly requirements for debenture interest and dividends on the preferred stock. The orders received by the French Westinghouse Company, from Jan. 1 to Sept. 30, being nine months of the fiscal year, indicate that the total business for 1907 will approach 20,000,000 francs. Among these orders is an important one for an installation of single-phase traction at Lyons.

Trade Publications.

SELF-CONTAINED ALTERNATORS.—Bulletin No. 205, of Fairbanks, Morse & Company, is devoted to belt-driven revolving-field alternators rated at from 20 to 150-kva. Standard machines are built for one, two or three phases, 60 cycles and for from 230 to 2300 volts.

ELECTRIC EXHAUST FANS are the subject of Bulletin 3504, just issued by the Emerson Electric Manufacturing Company of St. Louis. Such apparatus associated with Emerson motors is illustrated and described with full details, for both alternating and direct circuits.

RHEOSTATS.—Bulletin No. 4510 of the General Electric Company describes electrically operated, ratchet-driven rheostat switches. The handles of these switches are rotated by a ratchet wheel and pawl movement actuated by solenoids which consume a small amount of power.

RHEOSTATS consisting of a series of cast grids supported on insulated rods between cast end pieces are discussed at length in Bulletin No. 4499 of the General Electric Company. These rheostats are especially suited for railway service on account of their uniformity, strength and reliability.

DIRECT-CURRENT RAILWAY MOTORS.—The Westinghouse Electric & Mfg. Company has issued circular No. 1124 dealing with 90-hp railway motors intended for interurban service. Motors of a simila type, but rated at 75-hp, are described in circular No. 1106 of the same company.

TOBIN BRONZE.—The Ansonia Brass & Copper Company, New York, has issued a pamphlet on the subject of Tobin bronze. The uses for this metal are many, and the America's cup defenders, "Vigilant," "Columbia" and "Reliance" were made of it. The properties of Tobin bronze are defined and the advantages derived from its use are described in many testimonials.

SINGLE-PHASE WATT-HOUR METERS.—The Fort Wayne Electrical Works has issued a new edition of its instruction book for single-phase induction watt-hour meters. Full instructions are given covering every detail of installing and operating this type of meter, including speed adjustment, change in frequency and testing. Thirty-five diagrams are included relating to every matter in connection with the instrument which is ever likely to be required.

BLACK ENAMELED WIRE.—The Western Electric Company has published a little booklet on black enameled wire, which deals with the many direct and incidental advantages to be secured with this type of insulation, viz., an elastic yet resistant and firmly adhering film. The insulation is applied by special machinery, and the plant to produce it has lately been greatly increased. One of the leading merits, it is said, is that as compared with cotton or silk, it is very much less affected by heat, and will carry electrical energy under heat conditions that would cause cotton and silk to become charred and destroyed. The enamel will withstand a temperature as high as 500 deg. Fahr. for a considerable time without injury to its insulating qualities. It is not waterproof, but is proof against the moisture of the air, even in conditions of extremely high humidity over long periods. Data are given on these and other points.

FUEL ECONOMIZERS.—"Fuel Economizers at the Manhattan Power Station of the Interborough Rapid Transit Company, New York City," is a reprint of a paper read by R. B. Tomlinson before the New York Railway Club, showing by a careful analysis of tests and monthly records that the economizers in this plant are paying a net rate of 30.5 per cent upon the initial outlay. This is based upon a price of $3.00 per ton for coal and the average load at the time the economizers were put in. The output of the plant has been increased since the test was made. The plant contains 64 boilers of 520 b.h.p. each and the draft is produced by four brick chimneys. The pamphlet is well illustrated and should be of interest to designers and operators of large steam plants. It may be obtained by addressing the Green Fuel Economizer Company, of Matteawan, N. Y.

Business Notes.

MASSACHUSETTS CHEMICAL.—The Massachusetts Chemical Company, of Walpole, Mass., is exhibiting at the American Street & Interurban Railway Manufacturers' Association at Atlantic City, N. J., this week. Messrs. A. T. Baldwin, L. O. Duclos and A. E. Duclos represent the company with a full line of samples, descriptive literature and souvenirs.

WIRT APPARATUS.—Some months ago the Cutler-Hammer Manufacturing Company, of Milwaukee, announced its purchase of the Wirt Electric Company, of Philadelphia. The Wirt business has now been consolidated into the Cutler-Hammer New York plant at Park Avenue and 130th Street, where its manufacture will be continued. All outstanding Wirt accounts should be remitted to the general offices at Milwaukee.

RIDGWAY TEMPLETS.—The Ridgway Dynamo & Engine Company, of Ridgway, Pa., has sent us a set of templets showing the floor space occupied by its standard generating units in sizes from 10 kw to 200 kw, inclusive. These templets are made to a scale of ¼ in. to the foot and should be of great value to consulting engineers, architects and others who have occasion to lay out power plants. The company is distributing these templets to all who will have use for them and will gladly send a set on application.

THE BECK PACIFIC LAMP COMPANY, of San Francisco, Cal., has been in business on the Pacific Coast for over a year. It owns the patent rights on the Beck flaming arc lamp for the field west of the Continental Divide. Mr. Threw, president and general manager of the company, states that notwithstanding the chaotic conditions under which all business has been conducted in San Francisco during the past year, his company is well satisfied with the reception it has received from the electrical trade and central station men of the Western Slope, and faces the future with perfect confidence.